AN ASSESSMENT OF FREEZE BRAND AND PIT TAG RECOVERY DATA AT McNARY DAM, 1987

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ABSTRACT

This study evaluated mark recovery data from PIT-tagged and freeze-branded fish recovered at McNary Dam in 1987. Hatchery and river-run populations of yearling chinook salmon (Oncorhynchus tshawytscha), sockeye salmon (O. nerka) and steelhead (O. mykiss) were used in this investigation. Paired groups of PIT-tagged and freeze-branded juvenile salmonids were released upstream from McNary Dam and subsequently recaptured at that site.

PIT tags were recovered in significantly higher proportions than freeze brands regardless of species or stock. Furthermore, for chinook and sockeye salmon, PIT tag recovery data exhibited less variability. Reasons for the discrepant intermark recovery rates are discussed.

CONTENTS

INTRODUCTION

Recent studies conducted at Columbia River dams revealed that PIT-tagged yearling chinook salmon (Oncorhynchus tshawytscha) and steelhead (O. mykiss) were recovered at significantly higher rates than those that were freeze-branded (Prentice et al. 1987). In one study, river-run yearling chinook salmon were PIT-tagged or branded, released at the same time and location into the forebay, and subsequently recaptured at McNary Dam. Overall recovery rates for brands (expanded for sample size) and PIT tags (actual) were 38.9 and 63.6%, respectively. Similar results were observed at Lower Granite Dam when evaluating data for spring chinook salmon released from Dworshak National Fish Hatchery (DNFH) in 1986 (Prentice et al. 1987). At Lower Granite Dam, brands and PIT tags were recovered at a rate of 11.5 and 18.9%, respectively. This discrepancy in recovery rates persisted downstream at McNary Dam, with 8.9% of the brands and 10.8% of the PIT tags recovered at that site. Similar results were obtained for steelhead released from DNFH; at Lower Granite Dam, 20.2% of the brands and 38.1% of the PIT tags were recovered (Prentice et al. 1987). The large discrepancies in mark recovery rates suggest a potential bias may be associated with the recovery process.

Additional research was conducted by the National Marine Fisheries Service (NMFS) in 1987 to explore the recovery rates of branded and PIT-tagged fish. Specifically the objectives were to 1) determine if freeze-branded and PIT-tagged yearling chinook salmon, sockeye salmon (O. nerka), and steelhead are consistently recovered at different rates and 2) if discrepancies exist, attempt to identify the sources of error in the sampling process.

METHODS AND MATERIALS

Marking

Fish for the study were marked at a number of hatcheries: spring chinook salmon--Winthrop National Fish Hatchery (WNFH), steelhead and yearling fall chinook salmon--Lyons Ferry Hatchery (LFH), and steelhead--Wells Hatchery. Additionally, migrating yearling chinook and sockeye salmon were collected for marking at Priest Rapids Dam on the Columbia River (Fig. 1). Details regarding dates, sizes, and numbers marked for each test are summarized in Appendix A.

The spring chinook salmon at Priest Rapids Dam were the only groups branded exclusively for our evaluation; the other groups were branded primarily for other studies. Fish branded at the hatcheries were used for the Smolt Monitoring Program (SMP) evaluation and our study. Sockeye salmon branded at Priest Rapids Dam were marked by the NMFS for use in transportation evaluation (Dell et al. 1985).

Branding and PIT tagging were conducted concurrently for each release group. The only exception being that subsets of the three groups of spring chinook salmon branded in the fall at WNFH were remarked with the PIT tag in the spring. Freeze branding was done using methods described by Mighell (1969). The PIT-tagging method of auto-injection (Prentice et al. 1987) was used at all marking locations except WNFH, where the hand injection system was used (Prentice et al. 1986, Appendix A). The sockeye salmon at Priest Rapids were also adipose clipped and coded wire tagged (Jefferts et al. 1963) using multiple marking procedures described by Park et al. (1974).

Fish were selected from the general population for both mark methods, and unusable fish were culled from both mark groups using the same criteria. Fish were rejected prior to marking (brand or tag) if they were injured, descaled, previously marked, obviously diseased, or precocious males. Approximately 4% of the branded fish selected for tagging at WNFH were rejected because they exhibited obvious external signs of bacterial kidney disease (BKD).

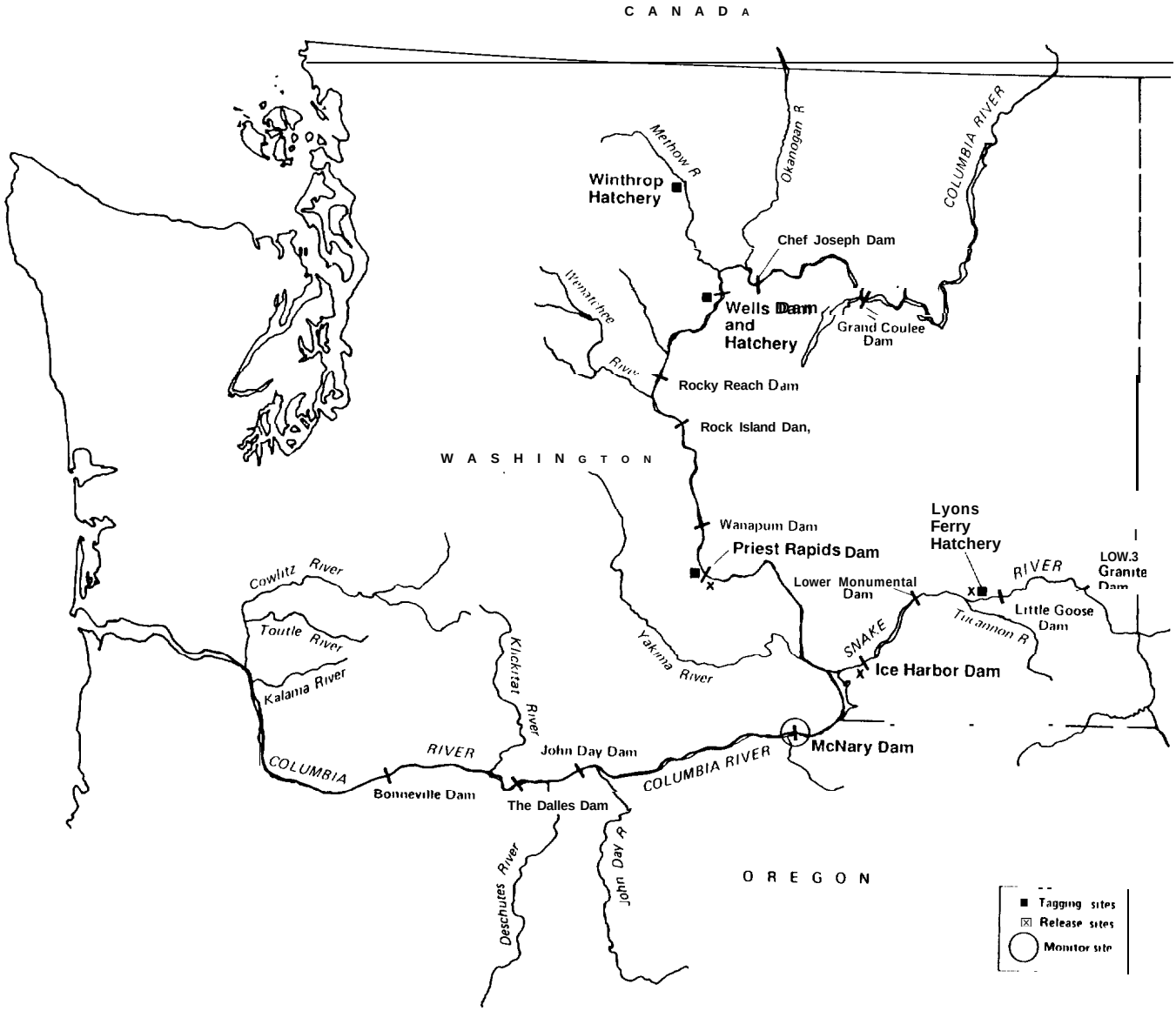

Figure l.--Locations of the marking, release, and monitor sites; 1987.

Some groups from Priest Rapids Dam were marked over several days due to the small numbers of fish available from the gatewell sampling on any single day. For the chinook salmon marked in this manner, brands were changed daily to identify individual release days.

Release

At LFH and WNFH marked fish were held at the hatcheries for several weeks prior to release, and mortalities were documented. Additionally, freeze-branded fish were evaluated for brand legibility by FPC staff (FPC 1988). To estimate the number of branded fish released, the number of observed mortalities and estimated number of illegible marks were deducted from the total number tagged. To document the number of PIT-tagged fish released, mixed groups of branded and PIT-tagged fish were pumped into tanker trucks for distribution. Tagged fish were interrogated as they passed through a pump fitted with a PIT tag detector (Prentice et al. 1988). Only the tag codes confirmed at the time of release were used for intermark comparisons in this evaluation.

At Wells Hatchery steelhead were released only 3 days after marking. At the end of the 3-day period, mortalities were enumerated and brands were examined for legibility. Release numbers were adjusted accordingly.

At Priest Rapids Dam, river-run fish were marked and released on the same day. Additionally, samples (n=50) of spring chinook and sockeye salmon were held for 5 days to document tag loss, delayed mortality, and brand legibility.

Most marked groups were released in the tailrace below Priest Rapids Dam. Only fish from LFH were released in different locations--fall chinook salmon were released directly from the hatchery whereas steelhead were released in the tailrace below Ice Harbor Dam. Marked fish (branded and tagged mixed together) were transported to the release sites via tanker trucks by FPC contractors (FPC 1988).

Monitoring

Marked fish were recovered at the McNary Dam collection facility. Brand recovery data were processed by NMFS personnel as part of the Smolt Monitoring Program. Branded fish were enumerated in a subsample systematically extracted from the bypass population. The estimated number of a particular brand present in the bypass population (often referred to as the "expanded' estimate) was calculated as the ratio of the number of brands observed in the sample to the proportion of time the sample was extracted (Giorgi and Sims 1987).

PIT-tagged fish were passively monitored while exiting the separator at McNary Dam (Prentice et al. 1987). The system interrogated 100% of the bypass population. An additional monitor placed in the sub-sample room identified tagged fish diverted into the subsample (Fig. 2).

PIT tag recovery data specify the date and time (to minute) tags were detected. Recovery data for brands were pooled over a 24-h period (noon to noon). For comparative purposes, daily PIT tag recovery data were adjusted to the same time frame.

RESULTS

A total of 8,120 PIT-tagged and 168,906 freeze-branded juvenile salmonids were marked in 1987 to evaluate the McNary Dam collection facility (Appendix A).

Recoveries

Yearling Chinook Salmon

A total of 564 PIT-tagged and an estimated 9,658 branded spring chinook salmon were detected from groups marked at Winthrop National Fish Hatchery and released below Priest Rapids Dam (Table 1). The mean recovery rate for three groups of PIT-tagged spring chinook was 44.0% (SD = 2.8%) (Table 2). Recovery rates for individual

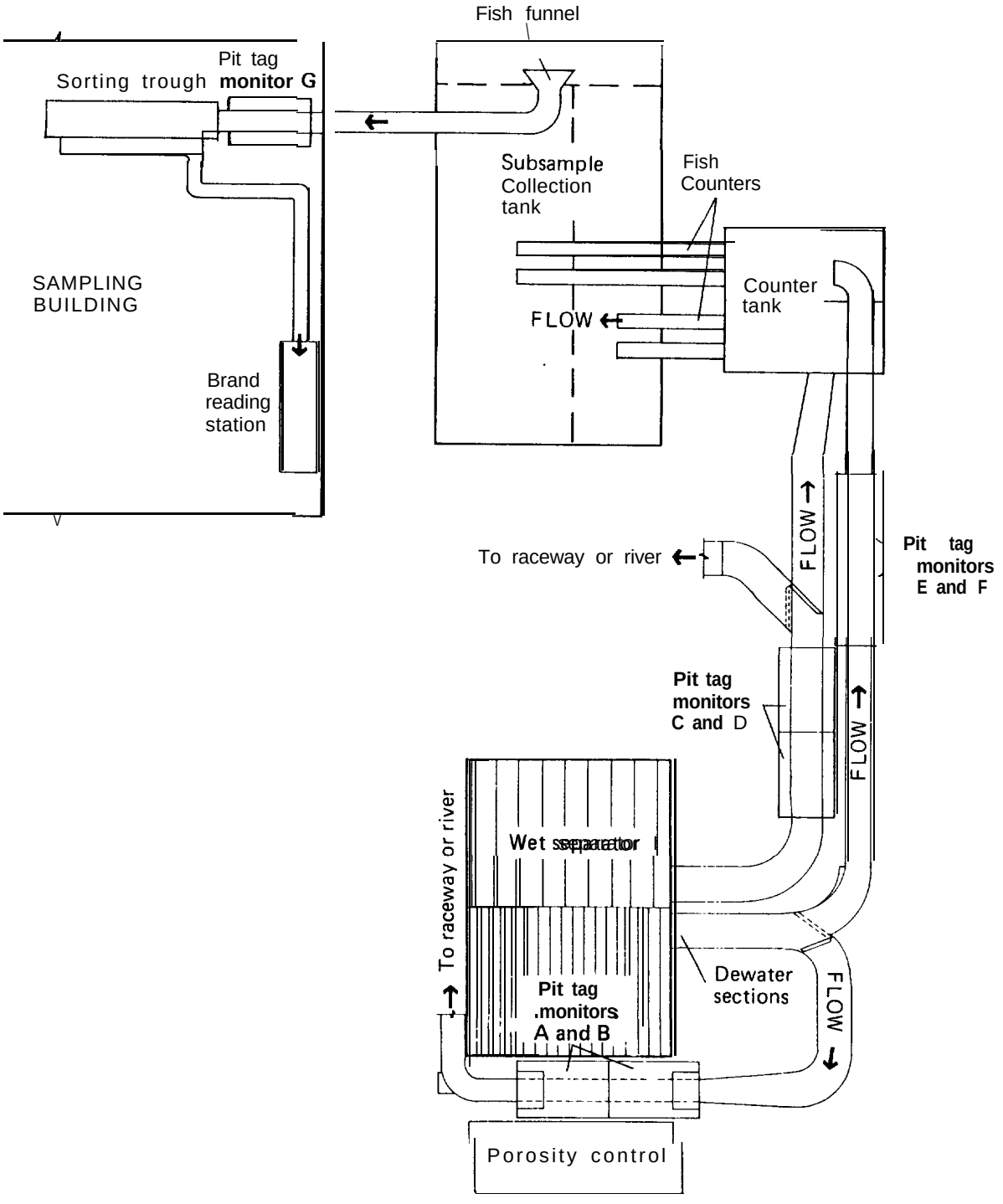

Figure 2.--Overview of the McNary Dam fish sampling system showing the location of PIT-tag monitors in 1987.

Table l.--Numbers of fish marked and released and recovery data summary for PIT-tagged and branded yearling chinook salmon from Lyons Ferry Hatchery, Winthrop Hatchery, and Priest Rapids Dam. PIT tag recoveries from Lyons Ferry and Winthrop hatcheries are reported only for those tags detected at the time of release.

Fish source and release date	Number marked		Number released		Number recovered			Percent recovered	
						Brand			Brand
	Pit tag	Brand	PIT tag[a]	Brand[b]	PIT tag	Sampled	Expanded	PIT tag	Exp.
LYONS FERRY									
14 Apr. 87	654	40.340	597[c]	39.312	242[d]	792	13,068	40.5	33.2
WINTHROP									
20 Apr. 87	660	12.230	303[c]	IO.658	132[d]	242	3,789	43.6	35.5
24 Apr. 87	654	12.200	43oc	II.029	178[d]	125	2,081	41.4	18.9
28 Apr. 87	678	12,200	542[c]	11,300	254[d]	215	3,788	46.9	33.5
Total	1.992	36,630	1,275	32,987	564	572	9.658		
PRIEST RAPIDS									
05 Hay 87	600	5,993	599	5,993	371	53	976	61.9	16.3
09 May 87	600	6,000	600	6.000	351	211	2,195	58.5	36.6
13-16 May 87	600	6.034	598	6,034	358	430	2,809	59.9	46.6
Total	I.800	18.027	1,797	18,027	1.080	694	5,980		

a Losses include raceway mortalities, tag rejections, and smolt condition sampling.

b Losses include raceway mortalities, adjustments for brand legibility, and smolt condition sampling.

c PIT tags detected at release using release monitors.

d PIT tags recaptured at McNary Dam from tags detected at release.

Table 2.--Mean recovery rate and standard deviation for groups of PIT-tagged and branded fish at McNary Dam, 1987.

Species or race	Source of fish	Mark	Number of groups	Recovery rate (%) Mean	SD
Spring chinook	Winthrop Hatchery	PIT	3	44.0	2.8
		Brand	3	29.3	9.1
Yearling chinook	Priest Rapids migrants	PIT	3	60.0	1.7
		Brand	3	33.1	15.4
Yearling Fall chinook	Lyons Ferry Hatchery	PIT	1	40.5	
		Brand	1	33.4	
Sockeye	Priest Rapids migrants	PIT	3	34.2	4.0
		Brand	3	22.8	10.0
Steelhead	Wells Hatchery	PIT	3	34.3	3.2
		Brand	3	26.9	1.9
Steelhead	Lyons Ferry Hatchery	PIT	3	30.4	2.5
		Brand	3	25.5	2.4

groups ranged from 41.4 to 46.9% (Table 1). The branded counterparts were recovered at a significantly ($P \leq 0.001$) lower rate of 29.3% (SD = 9.1%) (Table 3; Fig. 3).

Of 1,797 PIT-tagged and 18,027 branded river-run yearling chinook salmon marked and released at Priest Rapids Dam, 1,080 and 5,980 were recovered, respectively (Table 1). The three PIT-tagged groups were recovered at an average rate of 60.0% (SD = 1.7%) (Table 2). The corresponding branded groups were recovered at a significantly ($P<0.001$) lower rate of 33.1% (SD = 15.4%) (Tables 2 and 3; Fig. 3).

A total of 242 tagged and an estimated 13,068 branded fall chinook salmon were recovered from a single group marked at Lyons Ferry Hatchery (Table 1). Tags and brands were recovered at significantly ($P \leq 0.002$) different rates of 40.5 and 33.2%, respectively (Tables 1 and 3).

Steelhead

A total of 644 tagged and an estimated 9,224 branded steelhead were recovered from three paired groups marked at Wells Hatchery (Table 4). The mean recovery rate for three groups of PIT-tagged fish was 34.3% (SD = 3.2%). The branded counterparts were recovered at a significantly ($P \leq 0.001$) lower rate of 26.9% (SD = 1.9%) (Tables 2 and 3; Fig. 3).

A total 451 tagged and an estimated 8,729 branded fish were recovered from fish marked at Lyons Ferry Hatchery (Table 4). The mean recovery rate for three groups of tagged fish was 30.4% (SD = 2.5%). The branded counterparts were recovered at a significantly ($P \leq 0.001$) lower rate of 25.5% (SD = 2.4%) (Tables 2 and 3; Fig. 3).

Sockeye Salmon

A total of 616 tagged and an estimated 3,643 branded sockeye salmon were recovered from groups marked at Priest Rapids Dam (Table 5). The mean recovery rate for three groups of PIT-tagged fish was 34.2% (s.d. = 4.0%). The branded

Table 3.--Results from Chi-square test comparing recapture rates of PIT-tagged vs branded fish (1 degree of freedom). Recaptures were pooled over all replicates for these comparisons.

Species or race	Source of fish	X^2	Probability
Spring chinook	Winthrop Hatchery	131.2	≤0.0001
Yearling chinook	Priest Rapids migrants	516.7	<0.0001
Yearling fall chinook	Lyons Ferry Hatchery	14.1	≤0.0002
Sockeye	Priest Rapids migrants	110.6	<0.0001
Steelhead	Wells Hatchery	40.9	≤0.0001
Steelhead	Lyons Ferry Hatchery	148.5	<0.0001

Mark Recovery Rates (Means)
at McNary Dam, 1987

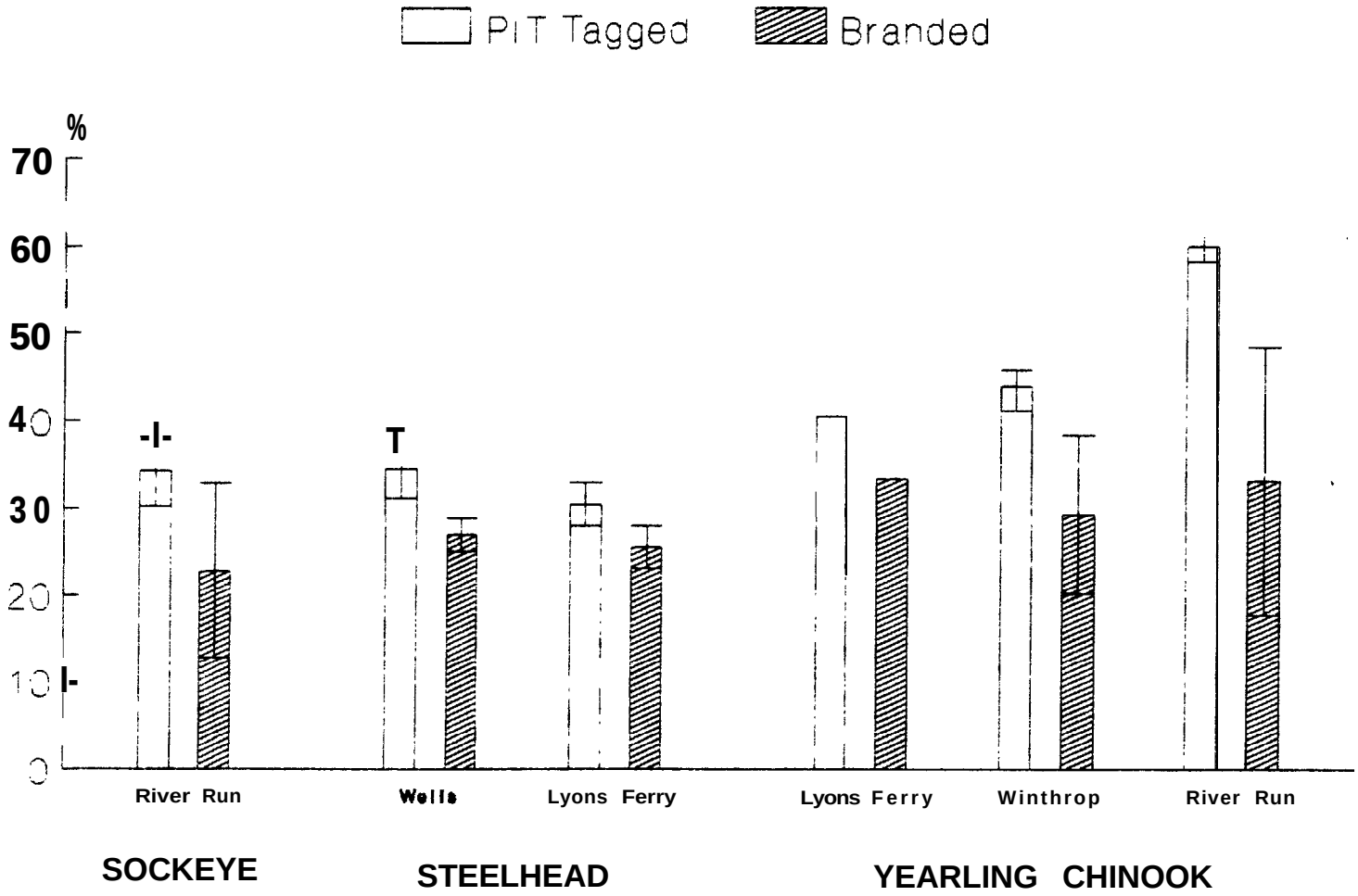

Figure 3. --Mean mark recovery (%) and standard deviations (vertical lines) for paired releases of PIT-tagged and branded fish recovered at McNary Dam in 1987 (K=3).

Table 4.--Number of fish marked and released and recovery data summary for PIT-tagged and branded steelhead. PIT tag recoveries from Lyons Ferry Hatchery are reported only for those tags detected at release.

Source and release Date	Number marked		Number released		Number recovered			Percent recovered	
						Brand			Brand
	PIT tag	Brand	PIT tag[a]	Brand[b]	PIT tag	Sampled	Expanded	PIT tag	(Expanded)
Wells									
23 Apr. 87	637	11.500	631	11.279	195	182	2,849	30.9	25.2
27 Apr. 87	633	11.430	632	10.898	220	204	3.303	34.8	28.9
01 May 87	630	11,546	616	11,375	229	174	3,072	37.2	26.6
Total	1.900	34.476	1,878	33.552	644	560	9.224		
Lyons Ferry									
23 Apr. 87	653	11,400	421[c]	11,279	116[d]	207	3.062	27.5	27.1
27 Apr. 87	659	11,600	533[c]	11.478	171[d]	173	2,612	32.1	22.8
01 May 87	653	11,590	524[c]	11,473	165[d]	207	3,055	31.5	26.6
Total	1.965	34.590	1,478	34.230	451	587	8,729		

a Losses include raceway mortalities- tag rejections, and smolt condition sampling.

b Losses include raceway mortalities, adjustments for brand legibility, and smolt condition sampling.

c PIT tags detected at release using release monitors.

d PIT tags recaptured at McNary Dam from tags detected at release.

Table 5.--Number of fish marked and released and recovery data summary for PIT-tagged and branded sockeye salmon from Priest Rapids Dam.

Release date	Number marked		Number released		Number recovered			Percent Recovered	
						Brand			Brand
	PIT tag	Brand	PIT tag	Brand	PIT tag	Sampled	Expanded	PIT tag	Expanded
7-14 hay 87	600	5.424	600	5.424	206	180	I.600	34.3	29.5
18-23 May 87	600	5,349	600	5.349	229	217	I.471	38.2	27.5
24-25 May 87	600	5,050	600	5,050	181	77	572	30.2	11.3
Total	1,800	15,823	1,800	15,823	616	474	3.643		

counterparts were recovered at a significantly ($P \leq 0.001$) lower rate of 22.8% (s.d. = 10.0%) (Tables 2 and 3; Fig. 3).

Sample Rate

The percentage of tagged fish exiting the separator, which were detected in the sample, ranged from 2.5 to 15.9% throughout the recovery period for each marked group (Table 6). Recoveries prior to 2 May were not included since the auxiliary detector in the sample room was not functional until that date. The sample rates based on tag recoveries varied considerably among and within species and stocks (Table 6). Generally, these rates were inconsistent with the sample rates estimated from the prescribed timer setting (estimated by FPC staff) prevailing during the same recovery periods (Table 6). These data suggest the sample may not be extracted at the rate prescribed on the timer. However, the evidence is inconclusive because the effective sampling rate associated with intradaily adjustments of the timer may not be truly reflected in the weighting factor used by the FPC (1988), and very few PIT-tagged fish entered the sample, thus the resultant estimated sample rate was questionable. We will attempt to resolve this problem in 1988 by releasing an ample number of tagged fish directly into the system and requesting that timer settings be adjusted once a day at a standard time.

Delayed Mortality

At Priest Rapids Dam, 50 fish of each species (chinook and sockeye salmon) and mark type were held for a 5-day period following marking to assess the extent of delayed mortality and tag rejection. No mortalities or tag rejections were observed in any group. Furthermore, all brands were legible 4 days after branding.

Table 6. Comparison of estimated sample rates over the recovery period for individual groups based on the ratio of PIT tags observed in the sample to those detected exiting the separator versus the prescribed timer setting over each marked recovery period. The prescribed daily rate was based on weighted rates calculated by the FPC and reflected in the estimated numbers of brands in the daily collection (Appendix B). Only fish recovered on and after 2 May are used in this analysis.

Stock	Source	Release date	Tags detected[1]			Estimated timer setting (%)
			Sample	Collection system	% of collected	
Spring chinook	Winthrop Hatchery	20 Apr	11	200	5.5	6.4
		24 Apr	9	237	3.8	6.0
		28 Apr	8	321	2.5	5.8
Yearling chinook	Priest Rapids migrants	05 May	13	371	3.5	5.4
		09 May	26	351	7.4	9.6
		13-16 May	57	358	15.9	15.3
Yearling fall chinook	Lyons Ferry	14 Apr	11	234	4.7	6.0
Sockeye	Priest Rapids migrants	07-14 May	11	205	5.4	11.2
		18-23 May	36	228	15.8	14.7
		24-25 May	24	183	13.1	13.5
Steelhead	Wells Hatchery	23 Apr	7	121	5.8	5.6
		27 Apr	15	197	7.6	6.1
		01 May	15	229	6.5	5.7
	Lyons Ferry	23 Apr	7	78	9.0	6.4
		27 Apr	7	149	4.7	6.6
		01 May	13	199	6.5	5.4

[1] All PIT tags detected at McNary Dam were used to construct this table, this includes tags from Winthrop and Lyons Ferry hatcheries which were not detected at the time of release but were subsequently detected at the dam.

DISCUSSION

When Prentice et al. (1986) reported that PIT-tagged river-run yearling chinook salmon were recovered at a significantly higher rate than branded counterparts, a criticism of the finding was that the brands may not have had sufficient time to develop prior to arriving at McNary Dam. In our study, hatchery stocks were examined and brand release groups were adjusted for legibility and post marking mortality using FPC data. Also, river-run fish marked at Priest Rapids Dam arrived at the brand reading room at McNary Dam no sooner than 4 days after marking, thus permitting sufficient time for brands to be developed. It appears then, that the difference in mark recovery was not due to poorly developed brands. However, this assumes that the adjustment for brand legibility as evaluated at the hatchery reflects the actual legibility of the brand several weeks later under the environmental conditions prevailing at the sampling site.

Furthermore, the data demonstrate that regardless of species or stock, PIT-tagged fish were recovered at significantly higher rates than their branded counterparts (Tables 2 and 3). The consistently low recovery of brands suggests that either the brand processing crew was missing brands in the sample or the sample was being diverted from the collected population at a rate different than the prescribed timer setting. In 1987, we attempted to address these two explanations by placing a PIT-tag detector in the sample room to interrogate every PIT-tagged fish entering the facility. Unfortunately, fewer PIT-tagged fish entered the sample than we anticipated, and as a consequence, we cannot draw any conclusions from the data. However in 1988, research will evaluate the source of sampling error with a study designed to provide adequate mark recoveries in the sample.

A key assumption underlying our interpretation of these results is that the tagging and branding processes have the same affect on the fish, in terms of survival,

behavior, or locomoting performance. Research by Prentice at al. (1987) supports this assumption. In that study, branded, CWT, PIT-tagged, and control groups of steelhead, as well as yearling and subyearling chinook salmon, were evaluated with respect to survival, swimming performance, and growth. No differences were observed among the groups.

Yearling chinook salmon from WNFH were handled in a different manner than the other lots of fish. These fish had been branded prior to the time they were tagged. Furthermore, approximately 4% were rejected for tagging because they exhibited gross BKD symptoms. This selective marking may in part be responsible for the higher recovery proportion of the tagged fish. However, the difference in mean recovery proportions are consistent with those observed in other groups of yearling chinook salmon (Table 1). Furthermore, the observed difference between tagged and branded fish far exceeds the amount which could be attributed to 4% culling.

PIT-tagged yearling chinook salmon from Winthrop Hatchery were consistently recovered at lower rates than their river-run counterparts from Priest Rapids Dam, averaging 44.0 and 60.0%, respectively (Tables 1 and 2). The disparity in recovery may be associated with differences in the behavioral characteristics of the two groups of fish. Hatchery fish released directly into the McNary Pool may have exhibited higher post-release mortality enroute to the dam. There is evidence to support this explanation. On the average, Winthrop fish (PIT- tagged) traversed the pool in 11.3 days whereas river-run chinook salmon from Priest Rapids Dam traveled the same distance in 5.3 days (Fig. 4). As a consequence, Winthrop fish could have incurred more predator related mortality, since they were in the pool for a more protracted period. Alternatively, fish released directly from the hatchery may not have been as smolted as the river-run population (Rondorf et al. 1985) and as a consequence may not have been collected at the same rate. Giorgi et al. (1988) presented data which indicate that yearling chinook salmon in the early stages of smolt development were not as

PIT TAGGED CHINOOK SALMON RELEASED AT PRIEST RAPIDS DAM

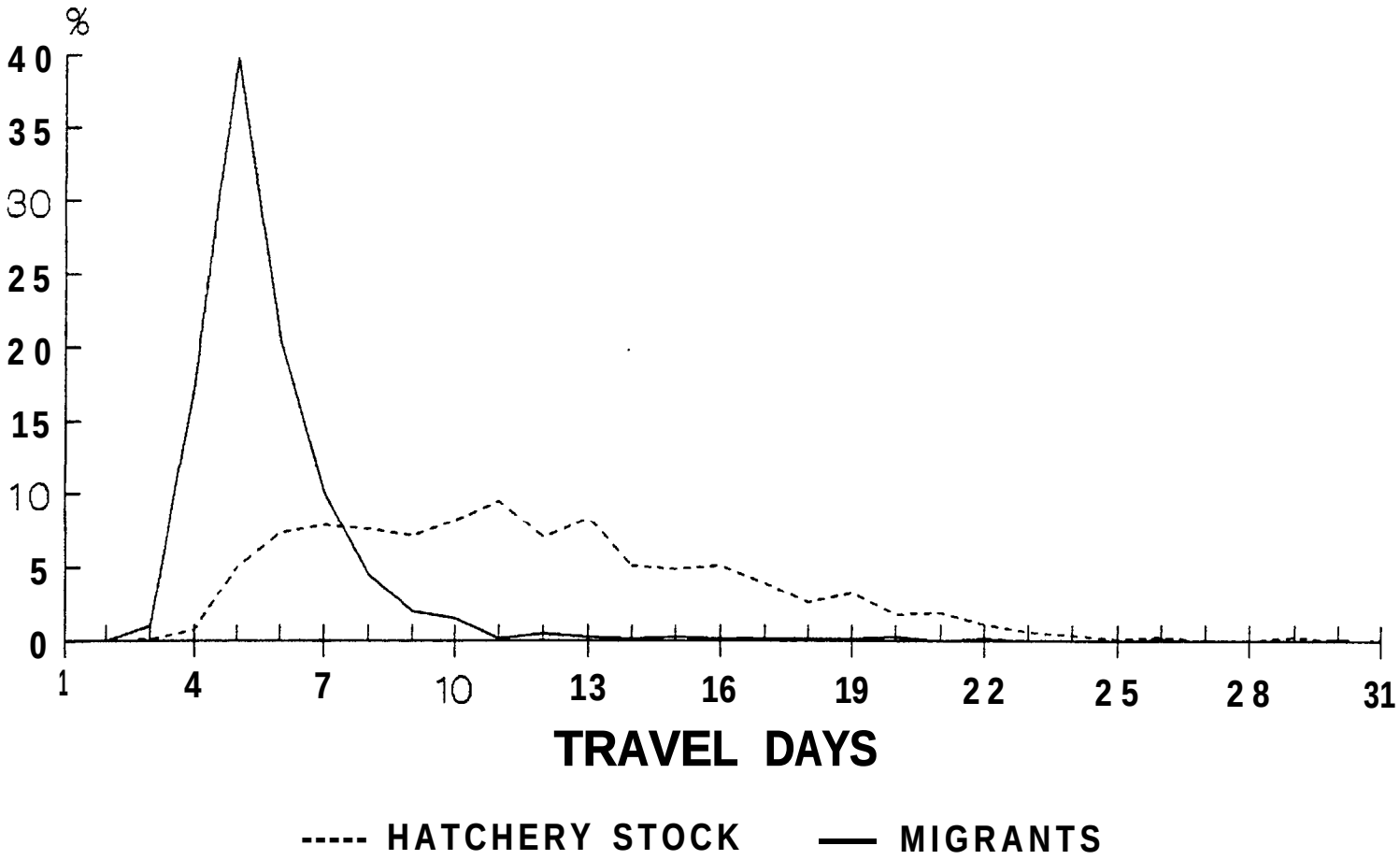

Figure 4.--Percent recovery of two PIT-tagged groups of yearling chinook salmon released below Priest Rapids Dam and recovered at McNary Dam in 1987. The hatchery fish were from Winthrop National Fish Hatchery. The migrants were river-run fish captured at Priest Rapids Dam.

susceptible to guidance by STSs as fish in later stages of smolt development. A third possible explanation is that the Winthrop groups may have passed the facility under high levels of spill and were subjected to a lower rate of collection; data, however, do not support this explanation. Peak passage of the Winthrop releases occurred during the first week of May (Appendix Fig. C2) whereas chinook salmon marked at Priest Rapids peaked about 1 week later (Appendix Fig. C3). Spill levels were actually lower during the passage of the Winthrop releases (Fig. 5) so collection should have been greater for these fish, just the reverse of what was observed.

The recovery data for sockeye salmon illustrated an important source of error associated with brands. Brand recovery for three groups ranged from 11.3 to 29.5% (Table 5) whereas the corresponding tagged groups ranged from 30.2 to 38.2%. Inspection of the frequency distribution (Appendix Fig. C6) for Group 1, shows an apparent pulse of branded (Brand LA W2) fish were recorded at the facility on 30 May; however, PIT tag recoveries did not indicate a similar increase in recovery numbers. It appears that the observed pulse of branded fish was actually comprised of misread brands from the third release group, Brand LA W4 (Fig. 6). This would explain why no fish were recorded from the third release group on 30 May and the inordinately low recovery rate (11.3%) for that group (Table 5).

Not all species left the separator at the same time of day. Regression patterns for sockeye salmon revealed a distinct peak movement near 2000 hours each day (Appendix Fig. D3). Conversely, chinook salmon and steelhead tended to leave the separator at a more uniform rate over the course of the day (Appendix Figs. Dl and D2). The extent to which these patterns affected the sample rate is uncertain. However, we anticipate that results from the 1988 studies will provide valuable insight into this process.

SPILL **CONDITION** AT McNARY DAM DURING EVALUATION PERIOD

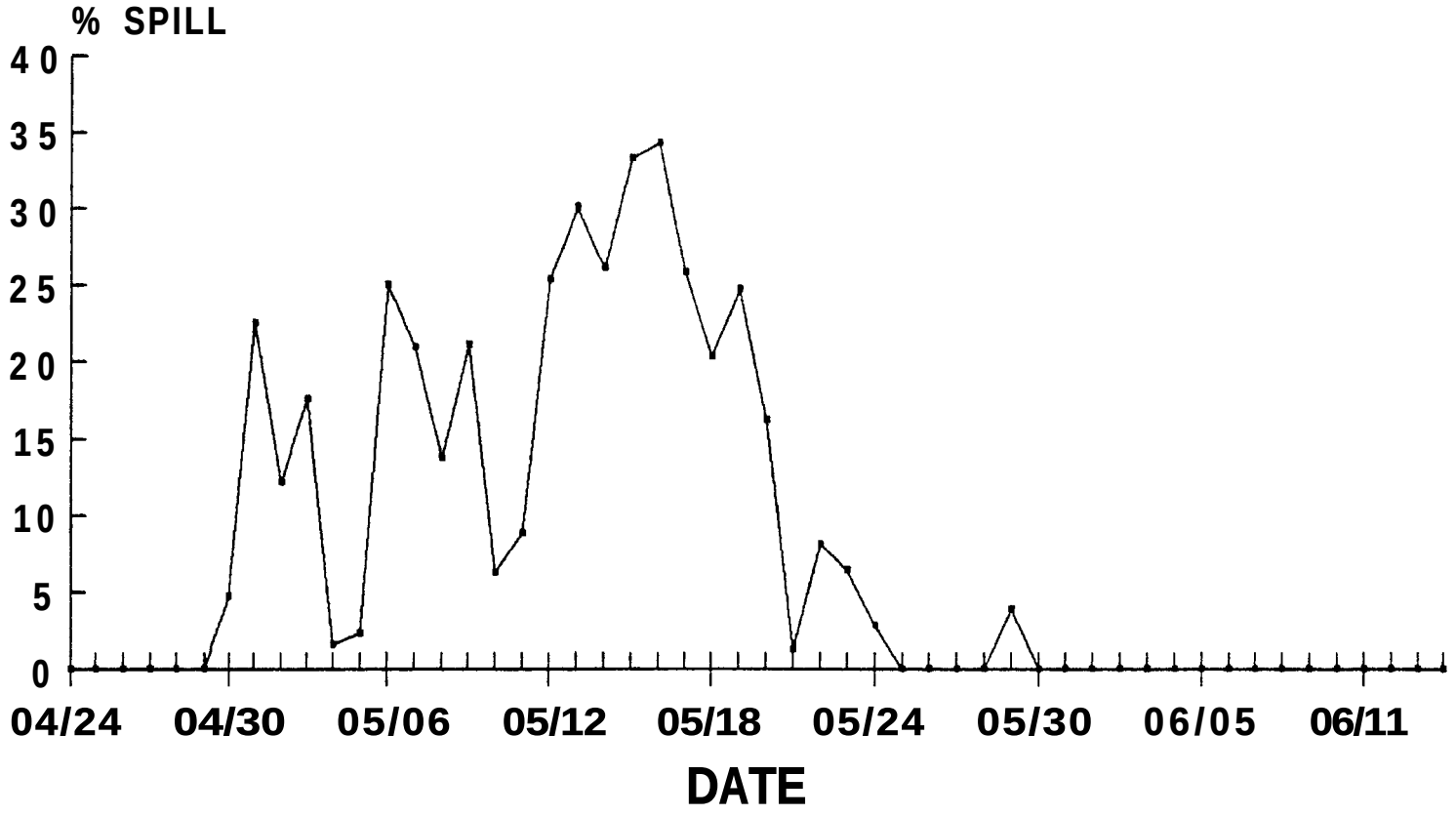

Figure 5.--Percentage spill occurring at McNary Dam in 1987.

McNARY BRAND OBSERVATIONS FOR PRIEST RAPIDS SOCKEYE GROUPS 1 & 3

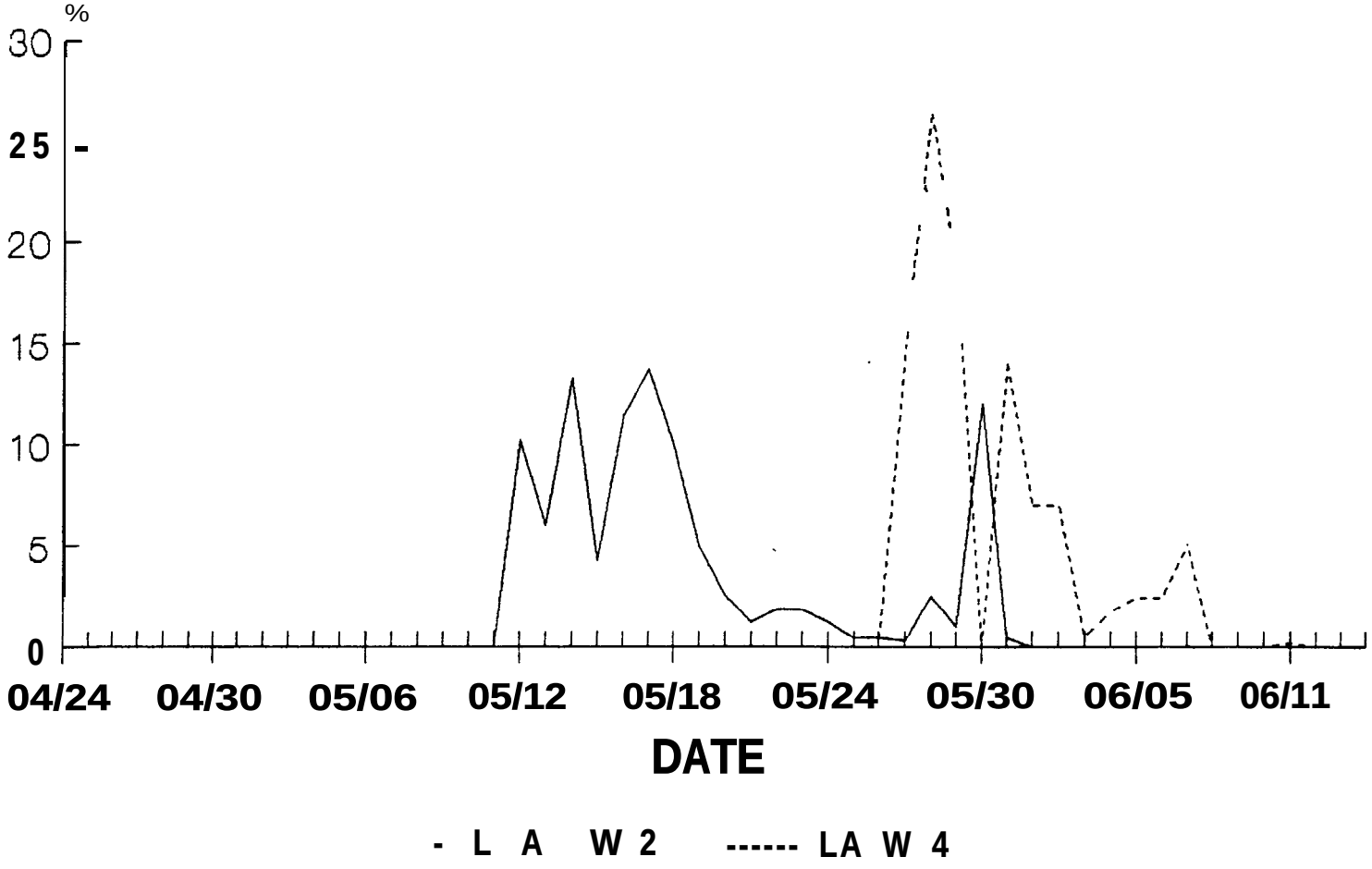

Figure 6 --Distribution of brand recoveries for two groups of river-run sockeye salmon released below Priest Rapids Dam and collected at McNary Dam in 1987.

SUMMARY AND CONCLUSIONS

1) PIT-tagged stocks of yearling chinook salmon, sockeye salmon, and steelhead were consistently recovered in significantly greater proportions than freeze-branded counterparts.
2) Brand recovery data for chinook and sockeye salmon were more variable than corresponding PIT-tag data.
3) The discrepancy between tag and brand recovery rates was not attributable to poor brand development.
4) Mistakes in the brand reading process were identified as one probable source of error which could account for some of the variability associated with recovery data for sockeye salmon.
5) Future research should address sources of error associated with the brand reading and subsampling process. An understanding of the extent of each source of error may enable managers to correct the deficiencies inherent in brand recovery data.

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APPENDIX A
Summaries of PIT Tagging and Freeze Branding

Appendix Table Al.--Summary of PIT Tagging and Freeze Branding at Lyons Ferry Washington Department of Fisherfes Hatchery, 1987.

Species	Fall chinook salmon
Tag date	30-31 March 1987
Water temperature	12°C
Number of groups tagged	1
PIT tag injection method	Auto-tagger
Length	Taken on all fish
Weight	Taken on 10%
Fish health	General good health. Low mortality prior to marking. Some fin rot observed on a few fish.

Group 1:

Number PIT tagged	654
Weight	min.=26.0 / max.=72.3 / ave.=47.1 g
Length	min.=85 / max.=203 / ave.=162 mm
Total fish branded	40,340
Associated brand	LA7Nl

Appendix Table A2.--Summary of PIT Tagging and Freeze Branding at Winthrop NFH, 1987.

Marking agencies PIT tag: NMFS
Brand : USFW (FAO Vancouver)
Species : Spring chinook salmon
Tag date : 17-18 March 1987
Brand date : 01-05 October 1987
Water temperature : 7.2°C
Number of groups tagged : 3
Number of fish tagged : 1,992
PIT tag injection method: Hand
Length : Taken on all fish
Weight : Taken on 10%
Brand quality : Checked on 33%
Fish health : Spring chinook salmon at Winthrop NFH historically have had BKD. This year fish were showing signs and recent mortality had elevated. During marking, 4% of the fish were rejected because of gross signs of BKD.

Group 1: (control 1)
Number PIT tagged : 660
Weight : min.=10.3 / ❑ ax.=29.9 / ave.=l9.7 g
Length : min.=97 / max.=165 / ave.=121 mm
Total fish in raceway: 12,230
Associated brand : RA7Fl

Group 2: (control 2)
Number PIT tagged 654
Weight min.= 4.2 / max.=41.0 / ave.=20.9 g
Length min.= 91 / max.=165 / ave.=116 mm
Total fish in raceway: 12,200
Associated brand LD7Fl

Group 3: (control 3)
Number PIT tagged : 678
Weight : min.= 3.0 / max.=39.1 /ave.=21.8 g
Length : min.= 75 / max.3173 /ave.=121 mm
Total fish in raceway: 12,220
Associated brand RA7S3

Appendix Table A3.--Summary of Chinook Salmon PIT Tagging and Freeze Branding at Priest Rapids Dam, 1987.

Species	Chinook salmon (spring, summer, & fall)
Tag date	05-13 May 1987
Water temperature	ll.l°C
Number of groups tagged	3
Number of fish tagged	1,847
Number of fish branded	17,993
PIT tag injection method	Auto-tagger
Length	Taken on all fish
Weight	Taken on 10%
Fish health	Fish were river run collect from gatewells at Priest Rapids Dam. All sick, previously marked, and highly descaled fish were removed prior to marking.
Comment	50 PIT tagged and branded fish were held in a 5-day holding test to determine delayed mortality, brand readability, and tag loss. No delayed mortality was observed, all brands were legible, and no tag loss was observed.
Group 1: (control 1)	
Number PIT tagged	599
Weight	min.=14.2 / max.=51.3 / ave.=26.8 g
Length	min.=96 / max.=193 / ave.=143 mm
Total fish branded	5,993
Associated brand	RAPPl
Raceway	Control tank
Release date	05 May 1987
Group 2: (control 2)	
Number PIT tagged	600
Weight	min.=l0.2 / max.=55.3 / ave.=26.8 g
Length	min.=89 / max.=185 / ave.=137 mm
Total fish branded	6,000
Associated brand	RAPP2
Raceway	Control tank
Release date	09 May 1987
Group 3: (control 3)	
Number PIT tagged	598
Weight	min.= 12.5 / max.= 62.7/ave.=27.8 g
Length	min.= 84 / max.= 188 /ave.=138 mm
Total fish branded	6,039
Associated brand	LAPP1(2591), LAPP2(1314), LDPPl(2143)
Raceway	Control tank
release dates	13, 15, 16 May 1987

Appendix Table A4.--Summary of PIT Tagging and Freeze Branding at Lyons Ferry Washington Department of Game Hatchery, 1987.

Species	Steelhead trout
Tag date	24-26 March 1987
Water temperature	14°C
Number of groups tagged	3
Number of fish tagged	1,965
PIT tag injection method	Auto-tagger
Length	Taken on all fish
Weight	Taken on 10%
Fish health	Fin erosion on all fish, some descaling - probably caused by fish pump. Mortality nil prior to marking.

Group 1: (control 1)

Number PIT tagged	653
Weight	min.=30.3 / max.=149.9 / ave.=62.0 g
Length	min.=152 / max.=255 / ave.=190 mm
Total fish in raceway	11,400
Associated brand	LA7Pl
Raceway	12

Group 2: (control 2)

Number PIT tagged	659
Weight	min.= 36.0 / max.=116.4 / ave.=67.1 g
Length	min.= 143 / max.=232 / ave.=185 mm
Total fish in raceway	11,600
Associated brand	LA7P3
Raceway	14

Group 3: (control 3)

Number PIT tagged	653
Weight	min.= 36.9 / max.=95.2 /ave.=69.2 g
Length	min.= 140 / max.=244 /ave.=194 mm
Total fish in raceway	11,590
Associated brand	RD7Pl
Raceway	16

Appendix Table A5.--Summary of PIT Tagging and Freeze Branding at Wells Hatchery, 1987.

Marking agencies PIT tag:	NMFS
Brand :	USFWS (FAO Vancouver, WA)
Species	Steelhead trout
Tag date	21-29 April 1987
Water temperature :	8°C
Number of groups tagged :	3
Number of fish tagged :	1,900
PIT tag injection method:	Auto-tagger
Length :	Taken on all fish
Weight	Taken on 30%
Fish health :	Steelhead trout at Wells Hatchery were in good condition. The only comment on fish health is that some fish had dorsal fin erosion. Approximately 5% of the fish were rejected because of precocity, and another 6% were culled because of small size (less than 145 mm).
Release remark	Fish were released within 3 days after marking. Close observation on mortalities as well as a close inspection of the raceway was made in order to determine the final release number. Nine PIT-tagged and 184 branded fish were left in the raceway after the last release. PIT-tagged fish were killed and removed from the release group while the branded fish were released from the hatchery.

Group 1: (control 1)

Number PIT tagged :	637
Weight :	min.=24.8 / max.=140.1/ ave.=72.3 g
Length :	min.=138 / max.=282 / ave.=196 mm
Total fish branded :	11,500
Associated brand :	RA7Hl
Release date :	23 April 1987

Group 2: (control 2)

Number PIT tagged :	633
Weight :	min.= 37.2/ max.=129.0/ ave.=74.3 g
Length :	min.= 152 / max.=241 / ave.3195 mm
Total fish branded :	11,430
Associated brand :	RA7H3
Release date :	27 April 1987

Group 3: (control 3)

Number PIT tagged :	630
Weight :	min.= 77.11 max.=132.2/ave.=77.0 g
Length :	min.= 149 / max.=239 /ave.=196 mm
Total fish branded :	11,546
Associated brand :	LD7Hl
Release date :	01 May 1987

Appendix Table A6.--Summary of Sockeye Salmon PIT Tagging and Freeze Branding at Priest Rapids Dam, 1987.

Species	Sockeye salmon
Tag date	07-25 May 1987
Water temperature	11°C
Number of groups tagged	3
Number of fish tagged	1,800
Number of fish branded	15,823
PIT tag injection method	Auto-tagger
Length	Taken on all fish
Weight	Taken on all fish
Fish health	Fish were river run collect from gatewells at Priest Rapids Dam. All sick, prevLously marked, and highly descaled fish were removed prior to marking.
Comment	During all marking periods fish were randomly sorted and PIT tagged at a 12% rate of those being branded. 130 fish were held in a 5 day holding test to determine delayed mortality and tag loss. Delayed mortality equaled 0, tag loss equaled 0.

Group 1: (control 1)

Number PIT tagged	600
Weight	min.=3.1 / max.=52.7 / ave.=8.2 g
Length	min.=76 / max.=180 / ave.=94 mm
Total fish branded	5,424
Associated brand	LAW 2
Raceway	Control tank
Release date	07-14 May 1987

Group 2: (control 2)

Number PIT tagged	600
Weight	min.=5.6 / max.=22.6 / ave.=ll.l g
Length	min.=86 / max.=140 / ave.=105 mm
Total fish branded	5,349
Associated brand	LAW 3
Raceway	Control tank
Release date	18-23 May 1987

Group 3: (control 3)

Number PIT tagged	600
Weight	min.=3.3 / max.=52.6 / ave.=13.8 g
Length	min.=84 / max.=170 / ave.=112 mm
Total fish branded	5,050
Associated brand	LAW 4
Raceway	Control tank
release dates	24-25 May 1987

APPENDIX B
Summaries of Recovery Data

Appendix Table Bl.--Summary of daily recovery data for yearling fall chinook salmon released from Lyons Ferry Hatchery, 1987.

Release date: 14 Apr. 1987 Release Time: 1500 hours
Number branded fish released: 39,312
Number PIT tagged fish released: 597 (confirmed)

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a] Number detected[b]	PIT tag recaptures[a] Percent of release Detected	PIT tag recaptures[a] Percent of release P.H. index	Brand recaptures Number Observed	Brand recaptures Number Expanded	Brand recaptures Percent of release Expanded	Brand recaptures Percent of release P.H. index
24 Apr	10	131.2	100.0	0	0.000	0.000	1	14	0.036	0.036
25 Apr	II	142.7	100.0	0	0.000	0.000	I	14	0.036	0.036
26 Apr	12	158.9	100.0	0	0.000	0.000	I	14	0.036	0.036
27 Apr	13	126.0	100.0	0	0.000	0.000	I	14	0.036	0.036
28 Apr	14	153.8	100.0	I	0.167	0.167	2	29	0.074	0.074
29 Apr	15	138.7	100.0	2	0.335	0.335	I0	143	0.364	0.364
30 Apr	16	206.1	95.24	7	I.172	I.231	20	286	0.727	0.763
01 May	17	254.1	17.47	8	1.340	1.730	28	400	I.017	I.313
02 May	18	225.6	87.86	9	3.183	3.622	75	789	2.007	2.256
03 May	19	239.7	82.42	33	5.527	6.707	162	1705	4.337	5.263
04 May	20	202.9	98.44	39	6.532	6.636	106	1752	4.457	3.467
05 May	21	212.6	97.73	43	7.203	7.370	91	2333	5.935	5.940
06 May	22	259.0	75.05	35	5.863	7.812	80	1778	4.523	6.026
07 May	23	248.8	79.08	13	2.177	2.754	51	879	2.236	2.829
08 May	24	241.9	86.24	16	2.680	3.108	20	444	I.129	I.310
09 May	25	269.9	78.91	3	0.502	0.637	27	648	1.648	2.065
10 May	26	253.0	93.76	4	0.670	0.715	19	465	I.183	1.262
1 I May	27	222.7	91.17	4	0.670	0.735	22	553	1.407	1.544
12 May	28	260.3	74.66	7	I.172	1.570	6	164	0.417	0.560
13 May	29	279.6	70.01	2	0.335	0.478	19	304	0.773	I.104
14 May	30	269.8	73.96	I	0.167	0.226	5	67	0.170	0.231
I5 May	31	263.3	66.79	0	0.000	0.000	7	69	0.175	0.262
16 May	32	279.6	65.75	3	0.502	0.764	5	36	0.092	0.140
17 May	33	251.3	74.27	0	0.000	0.000	5	33	0.084	0.112
18 May	34	230.2	79.73	0	0.000	0.000	3	30	0.076	0.097
19 May	35	231.1	75.32	0	0.000	0.000	0	0	0.000	0.000
20 Nay	36	202.3	83.80	0	0.000	0.000	3	21	0.053	0.064
21 May	37	181.5	98.74	0	0.000	0.000	3	20	0.051	0.051
22 May	38	195.3	91.89	0	0.000	0.000	2	I0	0.025	0.028
23 May	39	190.2	93.60	0	0.000	0.000	3	15	0.038	0.041
24 May	40	182.9	97.20	0	0.000	0.000	2	13	0.033	0.033
25 May	41	181.8	100.0	0	0.000	0.000	3	20	0.051	0.051
26 May	42	183.3	100.0	0	0.000	0.000	0	0	0.000	0.000
27 May	43	196.1	100.0	0	0.000	0.000	1	5	0.013	0.013
28 May	44	186.6	100.0	0	0.000	0.000	2	20	0.051	0.051
29 May	45	210.9	96.12	I	0.167	0.174	1	8	0.020	0.020
30 May	46	204.1	100.0	I	0.167	0.167	I	7	0.018	0.018
31 Hay	47	178.7	100.0	0	0.000	0.000	I	7	0.018	0.018
01 Jun	48	173.5	100.0	0	0.000	0.000	I	7	0.018	0.018
02 Jun	49	182.3	100.0	0	0.000	0.000	1	7	0.018	0.018
03 Jun	50	199.9	100.0	0	0.000	0.000	1	3	0.008	0.008
04 Jun	51	187.3	100.0	0	0.000	0.000	I	3	0.008	0.008
				242	40.500	46.900	793	13,129	33.400	37.600

[a] PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).
[b] Of the fish detected at the time of release.

Appendix Table B2a.--Summary of daily recovery data for spring chinook salmon, group 1, released from Winthrop NFH, 1987.

Release date: 20 April 1987 Release time: 1400 hours
Number branded flsh released: 10.658
Number PIT tagged fish released: 648(n) 303(c)

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number detected[b]	Percent of release		Number		Percent of release	
					Detected	P.H. index	Observed	Expanded	Expanded	P.H. index
25 Apr	5	142.7	100.0	0	0.000	0.000	0	0	0.000	0.000
26 Apr	6	158.9	100.0	1	0.330	0.330	0	0	0.000	0.000
27 Apr	7	126.0	100.0	1	0.330	0.330	2	29	0.272	0.272
28 Apr	8	153.8	100.0	1	0.330	0.330	1	14	0. 131	0.131
29 Apr	9	138.7	100.0	5	1.650	I.650	II	157	I.473	I.473
30 Apr	IO	206. I	95.24	12	3.960	4.158	12	171	I.604	I.681
01 Nay	II	254. I	77.47	9	2.970	3.834	13	186	1.604	2.071
02 May	12	225.6	87.86	3	0.990	1. 127	30	316	2.965	3.378
03 Nay	13	239.7	82.42	18	5.941	7.208	40	421	3.856	4.682
04 May	14	202.9	98.44	II	3.630	3.688	29	479	4.335	3.378
05 Nay	IS	212.6	97.13	8	2.640	2.702	II	282	2.646	2.712
06 May	16	259.0	75.05	12	3.960	5.277	16	356	3.340	4.447
07 May	17	248.8	79.08	9	2.970	3.756	16	276	2.590	3.274
08 Nay	18	241.9	86.24	8	2.640	3.061	IO	222	2.083	2.41 I
09 Nay	19	269.9	78.91	IO	3.300	4.182	IO	240	2.252	2.852
IO May	20	253.0	93.76	8	2.640	2.816	7	171	I.604	1.708
I I May	21	222.7	91. 17	4	1.320	I.448	2	50	0.469	0.516
12 Hay	22	260.3	74.66	3	0.990	1.326	6	164	1.539	2.064
13 May	23	279.6	70.01	3	0.990	I.414	6	96	0.901	1.285
14 May	24	269.8	73.96	1	0.330	0.446	7	93	0.873	I. 182
15 May	25	263.3	66.79	0	0.000	0.000	1	IO	0.094	0. 141
16 Play	26	279.6	65.75	2	0.660	I.004	3	22	0.206	0.310
17 May	27	251.3	74.27	0	0.000	0.000	2	13	0.122	0.169
18 Nay	28	230.2	79.73	0	0.000	0.000	0	0	0.000	0.000
19 May	29	231.1	75.32	2	0.660	0.876	0	0	0.000	0.000
20 hay	30	202.3	83.80	0	0.000	0.000	1	7	0.066	0.075
21 May	31	181.5	98.74	1	0.330	0.334	1	7	0.066	0.066
22 May	32	195.3	91.89	0	0.000	0.000	2	IO	0.094	0. 103
23 May	33	190.2	93.60	0	0.000	0.000	1	5	0.047	0.047
24 May	34	182.9	97.20	0	0.000	0.000	3	20	0.188	0.197
25 May	35	181.8	100.0	0	0.000	0.000	1	7	0.066	0.066
26 flay	36	183.3	100.0	0	0.000	0.000	0	0	0.000	0.000
27 May	37	196. I	100.0	0	0.000	0.000	0	0	0.000	0.000
28 Nay	38	186.6	100.0	0	0.000	0.000	0	0	0.000	0.000
29 Nay	39	210.9	96.12	0	0.000	0.000	0	0	0.000	0.000
30 Ray	40	204.1	100.0	0	0.000	0.000	0	0	0.000	0.000
31 Nay	41	178.7	100.0	0	0.000	0.000	0	0	0.000	0.000
01 Jun	42	173.5	100.0	0	0.000	0.000	0	0	0.000	0.000
02 Jun	43	182.3	100.0	0	0.000	0.000	1	7	0.066	0.066
				132	43.564	51.299	245	3.831	35.551	40.767

a PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).
b Of the fish detected at the time of release.

Appendix Table B2b.--Summary of daily recovery data for spring chinook salmon, group 2,released from Winthrop NFH, 1987.

Release date: 24 Apr 1987 Release time: 1400 hours
Number branded fish released: 11,028
Number PIT tagged fish released: 641(n) 430(c)

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a] Number detected[b]	PIT tag recaptures[a] Percent of release Detected	PIT tag recaptures[a] Percent of release P.H. index	Brand recaptures Number Observed	Brand recaptures Number Expanded	Brand recaptures Percent of release Expanded	Brand recaptures Percent of release P.H. index
28 Apr	4	153.8	100.0	0	0.000	0.000	0	0	0.000	0.000
29 Apr	5	138.7	100.0	0	0.000	0.000	0	0	0.000	0.000
30 Apr	6	206.1	95.24	4	0.930	0.930	5	71	0.517	0.544
01 May	7	254.1	77.47	7	1.628	2.093	I0	143	1.297	1.677
02 May	8	225.6	87.86	24	5.581	6.279	15	158	1.333	I.514
03 May	9	239.7	82.42	13	3.023	3.721	17	179	1.433	I.741
04 May	I0	202.9	98.44	23	5.349	5.349	17	281	2.094	1.632
05 May	II	212.6	97.73	20	4.651	4.651	4	103	0.934	0.952
06 May	12	259.0	75.05	17	3.953	5.349	I0	222	2.013	2.684
07 May	13	248.8	79.08	13	3.023	3.721	9	155	1.405	1.777
08 May	14	241.9	86.24	13	3.023	3.488	9	200	I.813	2.103
09 May	15	269.9	78.91	13	3.023	3.721		24	0.218	0.272
10 May	16	253.0	93.76	I0	2.326	2.558	8	196	1.777	1.895
II May	17	222.7	91.17	I0	2.326	2.558	7	174	1.596	1.750
12 May	18	260.3	74.66	3	0.698	0.930	3	82	0.743	0.997
13 May	19	279.6	70.01	6	1.395	2.093	7	112	I.015	I.451
14 May	20	269.8	73.96	I	0.233	0.231		13	0.118	0.163
15 May	21	263.3	66.79	I	0.233	0.231	0	0	0.000	0.000
16 May	22	279.6	65.75	0	0.000	0.000	2	15	0.136	0.208
17 May	23	251.3	74.27	0	0.000	0.000	2	13	0.118	0.163
18 May	24	230.2	79.73	0	0.000	0.000		I0	0.091	0.118
19 May	25	231.1	75.32	0	0.000	0.000	0	0	0.000	0.000
20 May	26	202.3	83.80	0	0.000	0.000	2	14	0.127	0.154
21 Ray	27	181.5	98.74	0	0.000	0.000	0	0	0.000	0.000
22 May	28	195.3	91.89	0	0.000	0.000	0	0	0.000	0.000
23 May	29	190.2	93.60	0	0.000	0.000	2	I0	0.091	0.100
				178	41.390	47.907	132	2,177	18.868	21.897

a PIT tag recapture dates (24 hour day midnight to midnight) have been shifted to match the brand date (noon to noon).
b Of the fish detected at the time of release.

Appendix Table B2c.--Summary of daily recovery data for spring chinook salmon, group 3, released from Winthrop NFH, 1987.

Release date: 28 Apr 1987 Release time: 1400 hours
Number nranded fish released: II.300
Number PIT tagged fish released: 667(n) 542(c)

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures" Number detected[b]	Percent of release Detected	P.H.	index	Brand recaptures Number Observed	Expanded	Percent of release Expanded	P.H.	index
01 May	4	254. I	77.47	I	0. 191	0.238		0	0	0.000	0.000	
02 May	5	225.6	87.86	5	0.954	1.050		12	126	1.026	I.168	
03 May	6	239.7	82.42	36	6.870	8.059		37	389	3.354	4.071	
04 Nay	7	202.9	98.44	47	8.969	8.809		32	529	4.531	3.522	
05 Nay	8	212.6	97.73	40	7.634	7.551		21	538	4.761	4.867	
06 May	9	259.0	75.05	24	4.580	5.900		34	756	6.690	8.911	
07 Nay	I0	248.8	79.08	17	3.244	3.966		13	224	I .982	2.504	
08 Nay	II	241.9	86.24	15	2.863	3.209		6	133	I.177	1.363	
09 May	12	269.9	78.91	14	2.672	3.273		7	168	I .487	I .885	
IO Nay	13	253.0	93.76	17	3.244	3.345		II	269	2.380	2.540	
I I May	14	222.7	91. 17	18	3.435	3.643		I0	251	2.221	2.434	
12 May	16	260.3	74.66	7	1.336	1.730		4	109	0.965	1.292	
13 Nay	17	279.6	70.01	4	0.763	1.054		7	I 12	0.991	I.416	
14 Nay	18	269.8	73.96	3	0.572	0.748		8	107	0.947	I.283	
15 Nay	19	263.3	66.79	2	0.382	0.552		0	0	0.000	0.000	
16 Hay	20	279.6	65.75	2	0.382	0.561		3	22	0.195	0.292	
17 Nay	20	251.3	74.27	0	0.000	0.000		5	33	0.292	0.389	
18 May	21	230.2	79.73	I	0. 191	0.231		2	20	0.177	0.221	
19 May	22	231.1	75.32	0	0.000	0.000		0	0	0.000	0.000	
20 May	23	202.3	83.80	I	0. 191	0.220		2	14	0.124	0.150	
21 Nay	24	181.5	98.74	0	0.000	0.000		2	13	0.115	0. I 15	
22 Hay	25	195.3	91.89	0	0.000	0.000		0	0	0.000	0.000	
23 May	26	190.2	93.60	0	0.000	0.000		I	5	0.044	0.044	
24 flay	27	182.9	97.20	0	0.000	0.000		0	0	0.000	0.000	
25 May	28	181.8	100.0	0	0.000	0.000		1	7	0.062	0.062	
				254	48.473	54.1419		218	3.825	33.522	38.531	

a PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).
b Of the fish detected at the time of release.

Appendix Table B3a.--Summary of daily recovery data for chinook salmon group 1, released from Priest Rapids Dam, 1987.

Release date: 05 May 1987 Release time: 2300 hours
Number branded fish released: 5.993
Number PIT tagged fish released: 599

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number detected	Percent of release Detected	P.H. index	Number Observed	Expanded	Percent of release Expanded	P.H. index
05 May	0	212.6	92.74	0	0.000	0.000	0	0	0.000	0.000
06 May	1	259.0	75.03	0	0.000	0.000	0	0	0.000	0.000
07 May	2	248.8	79.07	0	0.000	0.000	0	0	0.000	0.000
08 Nay	3	241.9	86.24	3	0.500	0.501	0	0	0.000	0.000
09 May	4	269.9	78.91	90	15.025	19.032	4	96	1.600	2.036
IO May	5	253.0	93.76	144	24.040	28.047	9	220	3.700	4.305
II Nay	6	222.7	91.17	64	10.684	II.686	7	176	2.937	3.220
12 May	7	260.3	74.66	33	5.509	7.346	5	136	2.269	3.037
13 May	8	279.6	70.01	19	3.172	4.507	9	144	2.403	3.437
14 May	9	269.8	73.96	4	0.668	0.835	9	120	2.002	2.703
15 May	IO	263.3	66.79	3	0.501	0.668	2	20	0.334	0.501
16 May	II	279.6	65.75	0	0.000	0.000	2	15	0.250	0.384
17 May	12	251.3	74.27	0	0.000	0.000	1	7	0.117	0.150
18 May	13	230.2	79.73	2	0.334	0.334	1	IO	0.167	0.217
19 May	14	231.1	75.32	1	0.167	0.167	1	IO	0.167	0.217
20 May	15	202.3	83.80	2	0.334	0.334	1	7	0.117	0.133
21 May	16	181.5	98.74	0	0.000	0.000	0	0	0.000	0.000
22 May	17	195.3	91.89	0	0.000	0.000	0	0	0.000	0.000
23 May	18	190.2	93.60	1	0.167	0.167	0	0	0.000	0.000
24 May	19	182.9	97.20	0	0.000	0.000	0	0	0.000	0.000
25 May	20	181.8	100.0	2	0.334	0.334	1	7	0.117	0.117
26 Nay	21	183.3	100.0	2	0.334	0.334	0	0	0.000	0.000
27 May	22	196.1	100.0	0	0.000	0.000	0	0	0.000	0.000
28 May	23	186.6	100.0	0	0.000	0.000	0	0	0.000	0.000
29 May	24	210.9	96.12	0	0.000	0.000	1	8	0.133	0.133
30 Ray	25	204.1	100.0	0	0.000	0.000	0	0	0.000	0.000
31 May	26	178.7	100.0	0	0.000	0.000	0	0	0.000	0.000
01 Jun	27	173.5	100.0	0	0.000	0.000	0	0	0.000	0.000
02 Jun	28	182.3	100.0	0	0.000	0.000	0	0	0.000	0.000
03 Jun	29	199.9	100.0	0	0.000	0.000	0	0	0.000	0.000
04 Jun	30	187.3	100.0	0	0.000	0.000	0	0	0.000	0.000
05 Jun	31	169.2	100.0	0	0.000	0.000	0	0	0.000	0.000
06 Jun	32	192.4	100.0	0	0.000	0.000	0	0	0.000	0.000
07 Jun	33	190.7	100.0	0	0.000	0.000	0	0	0.000	0.000
08 Jun	34	193.8	100.0	0	0.000	0.000	0	0	0.000	0.000
09 Jun	35	182.4	100.0	1	0.167	0.167	0	0	0.000	0.000
				371	61.937	74.457	53	976	16.312	20.591

a PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

Appendix Table B3b.--Summary of daily recovery data for chinook salmon group 2, released from Priest Rapids Dam, 1987.

Release date: 09 May 1987 Release time: 2300 hours
Number branded fish released: 6,000
Number PIT tagged fish released: 600

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number detected	Percent of release Detected	P.H.	index	Number Observed	Expanded	Percent or release Expanded	P.H. index
09 flay	0	269.9	78.91	0	0.000	0.000		0	0	0.000	0.000
IO May	1	253.0	93.76	0	0.000	0.000		0	0	0.000	0.000
11 May	2	222.7	91.17	0	0.000	0.000		0	0	0.000	0.000
12 May	3	260.3	74.66	0	0.000	0.000		0	0	0.000	0.000
13 Hay	5	279.6	70.01	45	7.500	10.667		5	80	1.333	I.900
14 May	6	269.8 263.3	66.79 73.96	184	30.667	41.333		81	1080	18.000	24.333
15 May				60	10.000	14.833		41	406	6.167	IO.133
16 May	7	279.6	65.75	24	4.000	6.000		35	255	4.250	6.467
17 May	8	251.3	74.27	8	1.333	1.667		25	167	2.783	3.750
18 flay	9	230.2	79.73	9	I.500	1.833		12	120	2.000	2.517
19 Nay	10	231.1	75.32	9	1.500	2.000		3	30	0.500	0.667
20 May	II	202.3	83.80	I	0.167	0.167		4	27	0.450	0.533
21 May	12	181.5	98.74	5	0.833	0.833		2	13	0.217	0.217
22 Hay	13	195.3	91.89	I	0.167	0.167		2	IO	0.167	0.183
23 Hay	14	190.2	93.60	I	0.167	0.167		0	0	0.000	0.000
24 May	15	182.9	97.20	0	0.000	0.000		I	7	0.117	0.117
25 May	16	181.8	100.0	0	0.000	0.000		0	0	0.000	0.000
26 May	17	183.3	100.0	I	0.167	0.167		0	0	0.000	0.000
27 May	18	196.1	100.0	0	0.000	0.000		0	0	0.000	0.000
28 May	19	186.6	100.0	0	0.000	0.000		0	0	0.000	0.000
29 Nay	20	210.9	96.12	0	0.000	0.000		0	0	0.000	0.000
30 Way	21	204.1	100.0	0	0.000	0.000		0	0	0.000	0.000
31 Hay	22	178.7	100.0	0	0.000	0.000		0	0	0.000	0.000
01 Jun	23	173.5	100.0	I	0.167	0.167		0	0	0.000	0.000
02 Jun	24	182.3	100.0	0	0.000	0.000		0	0	0.000	0.000
03 Jun	25	199.9	100.0	0	0.000	0.000		0	0	0.000	0.000
04 Jun	26	187.3	100.0	0	0.000	0.000		0	0	0.000	0.000
05 Jun	27	169.2	100.0	I	0.167	0.167		0	0	0.000	0.000
06 Jun	28	192.4	100.0	0	0.000	0.000		0	0	0.000	0.000
07 Jun	29	190.7	100.0	0	0.000	0.000		0	0	0.000	0.000
08 Jun	30	194.0	100.0	0	0.000	0.000		0	0	0.000	0.000
09 Jun	31	182.4	100.0	I	0.167	0.167		0	0	0.000	0.000
				351	58.500	80.333		211	2.195	36.583	50.817

a PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

Appendix Table B3c.--Summary of daily recovery data for chinook aalmon group 3, released from Priest Rapids Dam, 1987.

Summary of Recaptures (by day) for Preist Rapids Chinook Release 3
Release Date: 05/13/87 through 05/16/87 Release Time: 23:00
Number Branded Fish Released: 6,039
Number PIT Tagged Fish Released: 598

Recapture date	River flow	%Power house flow	PIT tag recaptures' Number detected	PIT tag recaptures' Percentage Detected	PIT tag recaptures' Percentage P.H.Index	Brand recaptures Number Observed	Brand recaptures Number Expanded	Brand recaptures Percentage Expanded	Brand recaptures Percentage P.H.Index
16 May	**279.6**	65.7	8	1.338	2.007	5	37	0.613	**0.927**
17 May	251.3	74.3	46	7.692	9.866	42	280	4.640	5.961
18 May	230.2	19.7	42	7.023	9.030	31	310	5.137	6.673
19 May	231.1	75.3	36	6.020	7.692	28	280	4.640	6.027
20 May	202.3	83.8	60	10.033	11.371	45	315	5.220	**5.961**
21 May	181.5	98.7	40	6.689	6.689	34	227	3.762	**3.759**
22 May	195.3	91.9	56	9.364	10.201	96	480	7.955	8.743
23 May	190.2	93.6	38	6.354	6.689	65	325	5.386	5.729
24 May	182.9	97.2	13	2.174	2.174	39	260	4.309	4.421
25 May	181.8	100.0	9	1.505	1.505	17	113	1.873	1.871
26 May	183.3	100.0	1	0.167	0.167	10	66	1.094	1.093
27 May	196.1	100.0	1	0.167	0.167	6	30	0.497	0.497
28 May	186.6	100.0	1	0.167	0.167	2	20	0.331	0.331
29 May	210.9	96.1	0	0.000	0.000	2	16	0.265	0.265
30 May	204.1	100.0	0	0.000	0.000	2	13	0.215	0.215
31 May	178.7	100.0	1	0.167	0.167	3	20	0.331	0.331
01 Jun	173.5	100.0	1	0.167	0.167	1	7	0.116	0.116
02 Jun	182.3	100.0	1	0.167	0.167	0	0	0.000	0.000
03 Jun	199.9	100.0	0	0.000	0.000	1	3	0.050	0.050
04 Jun	187.3	100.0	1	0.167	0.167	0	0	0 .000	0.000
05 Jun	169.2	100.0	0	0.000	0.000	0	0	0.000	0.000
06 Jun	192.4	100.0	1	0.167	0.167	0	0	0.000	0.000
07 Jun	190.7	100.0	0	0.000	0.000	0	0	0.000	0.000
08 Jun	193.8	100.0	1	0.167	0.167	0	0	0.000	0.000
09 Jun	182.4	100.0	1	0.167	0.167	0	0	0.000	0.000
			358	59.866	68.896	**429**	2802	46.437	52.972

[1] PIT tag recapture dates (24 hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

Appendix Table B4a.--Summary of daily recovery data for steelhead group 1, released from Lyons Ferry WDG hatchery, 1987.

Release date: 04/23/87 Release time: 1300 hours
Number branded fish released: 11,279
Number PIT tagged fish released: 650(n) 421(c)

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number detected[b]	Percent of release		Number		Percent of release	
					Detected	P.H. index	Observed	Expanded	Expanded	P.H. index
26 Apr	3			!	0.237	0.237	5	71	0.629	0.629
27 Apr	4	126.0 158.9	100.0 100.0	2	0.475	0.475	5	71	0.629	0.629
28 Apr	5	153.8	100.0	9	2.138	2.138	17	243	2.154	2.154
29 Apr	6	138.7	100.0	14	3.325	3.325	23	329	2.917	2.917
30 Apr	7	206.1	95.24	19	4.513	4.739	46	657	5.825	5.985
01 May	8	254.1	77.47	21	4.988	6.439	31	443	3.928	4.823
02 flay	9	225.6	87.86	8	1.900	2.163	22	232	2.057	2.252
03 flay	10	239.7	82.42	7	1.663	2.017	15	158	I.401	1.702
04 May	11	202.9	98.44	7	1.663	1.689	7	191	1.693	0.798
05 May	12	212.6	97.73	7	1.663	1.701	3	77	0.683	0.700
06 May	13	259.0	75.05	5	I.188	1.582	4	89	0.789	1.055
07 flay	14	248.8	79.08	I	0.237	0.300	3	52	0.461	0.585
08 May	15	241.9	86.24	I	0.237	0.275	5	III	0.984	1.144
09 flay	16	269.9	78.91	4	0.950	1.204	2	48	0.426	0.541
10 May	17	253.0	93.76	I	0.237	0.253	3	73	0.647	0.691
II Nay	18	222.7	91.17	I	0.237	0.260	3	75	0.665	0.727
12 May	19	260.3	74.66	2	0.475	0.636	0	0	0.000	0.000
13 May	20	279.6	70.01	I	0.237	0.339	4	64	0.567	0.807
14 May	21	269.8	73.96	0	0.000	0.000	!	13	0.115	0.160
IS Hay	22	263.3	66.79	0	0.000	0.000	2	20	0.177	0.266
16 May	23	279.6	65.75	0	0.000	0.000	2	15	0.133	0.204
17 Hay	24	251.3	74.27	2	0.475	0.639	0	0	0.000	0.000
18 May	25	230.2	79.73	0	0.000	0.000	1	IO	0.089	0.115
19 May	26	231.1	75.32	0	0.000	0.000	I	IO	0.089	0.115
20 May	27	202.3	83.80	0	0.000	0.000	I	7	0.062	0.071
21 May	28	181.5	98.74	0	0.000	0.000	0	0	0.000	0.000
22 May	29	195.3	91.89	0	0.000	0.000	0	0	0.000	0.000
23 Hay	30	190.2	93.60	0	0.000	0.000	0	0	0.000	0.000
24 Ray	31	182.9	97.20	I	0.237	0.244	0	0	0.000	0.000
04 Jun	42	187.3	100.0	0	0.000	0.000	I	3	0.027	0.027
09 Jun	46	182.4	100.0	I	0.237	0.237	0	0	0.000	0.000
18 Jun	54	-	-	I	0.237	0.000	0	0	0.000	0.000
				i-z	27.553	30.897	207	3,062	27.148	29.098

a PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).
b Of the fish detected at the time of release.

Appendix Table B4b.--Summary of daily recovery data for steelhead group 2, released from Lyons Ferry WDG hatchery, 1987.

Release date: 27 Apr 1987 Release time: 1300 hours
Number branded fish released: II.478
Number PIT tagged fish released: 647(n) 533(c)

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a] Number detected[b]	PIT tag recaptures[a] Percent of release Detected	P.H. index	Brand recaptures Number Observed	Expanded	Brand recaptures Percent of release Expanded	P.H. index
29 Apr	2	138.7	100.0	0	0.000	0.000	0	0	0.000	0.000
30 Apr	3	206.1	95.24	17	3.189	3.349	8	114	0.993	1.045
01 May	4	254.1	77.47	28	5.253	6.781	19	271	2.361	3.049
02 May	5	225.6	87.86	16	3.002	3.417	28	295	2.570	2.718
03 May	6	239.7	82.42	15	2.814	3.414	24	253	2.204	2.561
04 nay	7	202.9	98.44	16	3.002	3.049	II	301	2.622	0.897
05 May	8	212.6	97.73	12	2.251	2.304	2	51	0.444	0.453
06 Hay	9	259.0	75.05	7	I.313	1.750	7	156	1.359	I.812
07 May	I0	248.8	79.08	9	1.689	2.135	18	310	2.701	3.041
08 May	II	241.9	86.24	8	I.501	1.740	12	267	2.326	2.701
09 May	12	269.9	78.91	7	I.313	1.664	7	168	1.464	1.856
I0 May	13	253.0	93.76	I0	1.876	2.001	3	73	0.636	0.680
11 May	14	222.7	91.17	5	0.938	1.029	I	25	0.218	0.235
12 May	15	260.3	74.66	7	I.313	1.759	2	55	0.479	0.645
13 May	16	279.6	70.01	3	0.563	0.804	3	48	0.418	0.601
14 May	17	269.8	73.96	0	0.000	0.000	3	40	0.348	0.470
15 Nay	18	263.3	66.79	2	0.375	0.562	6	59	0.514	0.767
16 May	19	279.6	65.75	2	0.375	0.571	4	29	0.253	0.383
17 May	20	251.3	74.27	0	0.000	0.000	I	7	0.061	0.078
18 May	21	230.2	79.73	0	0.000	0.000	I	I0	0.087	0.113
19 Nay	22	231.1	75.32	0	0.000	0.000	2	20	0.174	0.235
20 May	23	202.3	83.80	1	0.188	0.224	0	0	0.000	0.000
21 May	24	181.5	98.74	0	0.000	0.000	I	7	0.061	0.061
22 May	25	195.3	91.89	0	0.000	0.000	I	5	0.044	0.044
23 May	26	190.2	93.60	0	0.000	0.000	I	5	0.044	0.044
24 May	27	182.9	97.20	1	0.188	0.193	I	7	0.061	0.061
25 Nay	28	181.8	100.0	I	0.188	0.188	0	0	0.000	0.000
26 Nay	29	183.3	100.0	0	0.000	0.000	0	0	0.000	0.000
27 Nay	30	196.1	100.0	0	0.000	0.000	2	I0	0.087	0.087
28 May	31	186.6	100.0	I	0.188	0.188	0	0	0.000	0.000
30 May	41	204.1	100.0	0	0.000	0.000	I	7	0.061	0.061
03 Jun	45	199.9	100.0	0	0.000	0.000	1	3	0.026	0.026
08 Jun	50	194.0	100.0	I	0.188	0.188	0	0	0.000	0.000
II Jun	53	187.5	100.0	0	0.000	0.000	I	1	0.009	0.009
II Jun	54	140.0	100.0	0	0.000	0.000	I	1	0.009	0.009
12 Jun	55	154.7	100.0	0	0.000	0.000	I	14	0.122	0.122
				iii	31.895	37.497	173	2.612	22.76	24.865

[1] PIT tag recapture dates (24 hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

2 Of the fish detected at the time of release.

Appendix Table B4c.--Summary of daily recovery data for steelhead group 3, released from Lyons Ferry WDG hatchery, 1987.

Release date: 01 May 1987 Release time: 1300 hours
Number branded fish released: Il.473
Number PIT tagged fish released: 644(n) 524(c)

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number detected[b]	Percent of release		Number		Percent of release	
					Detected	P.H. index	Observed	Expanded	Expanded	P.H. index
01 May	0	254.1	77.47	0	0.000	0.000	2	29	0.253	0.322
02 nay	I	225.6	87.86	0	0.000	0.000	0	0	0.000	0.000
03 Hay	2	239.7	82.42	4	0.763	0.926	I0	105	0.915	1.002
04 nay	3	202.9	98.44	27	5.153	5.234	17	464	4.044	1.900
05 nay	4	212.6	97.73	20	3.817	3.905	13	333	2.902	2.972
06 May	5	259.0	75.05	25	4.771	6.357	13	289	2.517	3.356
07 May	6	248.8	79.08	13	2.481	3.137	14	241	2.101	2.658
08 May	7	241.9	86.24	I0	1.908	2.213	16	356	3.103	3.600
09 May	8	269.9	78.91	6	I.145	I.451	8	192	1.673	2.118
lo nay	9	253.0	93.76	5	0.954	I.018	7	171	1.490	1.586
II May	I0	222.7	91.17	12	2.290	2.512	7	176	1.534	1.682
12 nay	II	260.3	74.66	4	0.763	1.022	7	191	1.665	2.231
13 May	12	279.6	70.01	8	1.527	2.181	5	80	0.697	0.994
14 May	13	269.8	73.96	6	I.145	1.548	6	80	0.697	0.941
15 May	14	263.3	66.79	3	0.572	0.857	9	89	0.776	I.159
16 May	15	279.6	65.75	5	0.954	I.451	7	51	0.444	0.680
17 May	16	251.3	74.27	I	0.191	0.257	I	7	0.061	0.078
18 May	17	230.2	79.73	2	0.382	0.479	4	40	0.349	0.436
19 nay	18	231.1	75.32	1	0.191	0.253	2	20	0.174	0.235
20 May	19	202.3	83.80	2	0.382	0.455	2	14	0.122	0.148
21 May	20	181.5	98.74	2	0.382	0.386	2	13	0.113	0.113
22 May	21	195.3	91.89	I	0.191	0.208	I	5	0.044	0.044
23 May	22	190.2	93.60	0	0.000	0.000	2	I0	0.087	0.096
24 nay	23	182.9	97.20	2	0.382	0.393	0	0	0.000	0.000
25 May	24	181.8	100.0	0	0.000	0.000	I	7	0.061	0.061
26 May	25	183.3	100.0	2	0.382	0.382	0	0	0.000	0.000
27 May	26	196.1	100.0	I	0.191	0.191	I	5	0.044	0.044
28 Ray	27	186.6	100.0	1	0.191	0.191	I	I0	0.087	0.087
29 nay	28	210.9	96.12	0	0.000	0.000	0	0	0.000	0.000
30 May	29	204.1	100.0	0	0.000	0.000	I	7	0.061	0.061
02 Jun	32	182.3	100.0	0	0.000	0.000	I	7	0.061	0.061
04 Jun	34	187.3	100.0	0	0.000	0.000	I	3	0.026	0.026
07 Jun	37	190.7	100.0	0	0.000	0.000	2	29	0.253	0.253
I0 Jun	40	198.8	100.0	I	0.191	0.191	0	0	0.000	0.000
14 Jun	44	123.0	100.0	0	0.000	0.000	I	14	0.122	0.122
19 Jun	49	122.8	100.0	0	0.000	0.000	I	17	0.148	0.148
26 Jul	86	-	100.0	I	0.191	0.191	0	0	0.000	0.000
				165	31.489	37.390	165	3.055	26.628	29.216

a PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).
b Of the fish detected at the time of release,

Appendix Table B5a.--Summary of daily recovery data for steelhead group 1, released from Wells WDG hatchery, 1987.

Release date: 23 Apr 1987 Release time: 1600 hours
Number branded fish released: Il.279
Number PIT tagged fish released: 631

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number detected	Percent of release Detected	P.H. index	Number Observed	Expanded	Percent of release Expanded	P.H. index
27 Apr	4	126.0	100.0	0	0.000	0.000	0	0	0.000	0.000
28 Apr	5	153.8	100.0	3	0.475	0.475	3	43	0.381	0.381
29 Apr	6	138.7	100.0	23	3.645	3.645	6	86	0.762	0.629
30 Apr	7	206.1	95.24	20	3.170	3.328	14	200	1.773	1.330
01 May	8	254.1	77.47	28	4.437	5.728	26	371	3.289	4.087
02 Bay	9	225.6	87.86	I2	1.902	2.164	25	263	2.332	2.651
03 May	10	239.7	82.42	20	3.170	3.846	26	274	2.430	2.722
04 nay	II	202.9	98.44	14	2.219	2.254	6	164	1.454	0.683
05 Hay	12	212.6	97.73	II	1.743	1.784	5	128	1.135	1.161
06 Hay	13	259.0	75.05	9	1.426	1.900	2	44	0.390	0.523
07 May	14	248.8	79.08	14	2.219	2.806	5	86	0.762	0.966
08 May	15	241.9	86.24	7	I.109	1.286	II	244	2.163	2.509
09 nay	16	269.9	78.91	4	0.634	0.803	7	168	1.489	1.888
in flay	17	253.0	93.76	7	I.109	I.183	5	122	1.082	I.153
I I nay	18	222.7	91.17	5	0.792	0.869	7	176	1.560	1.711
12 May	19	260.3	74.66	4	0.634	0.849	8	218	1.933	2.589
13 May	20	279.6	70.01	3	0.475	0.679	6	96	0.851	I.215
14 nay	21	269.8	73.96	5	0.792	I.071	2	27	0.239	0.328
15 May	22	263.3	66.79	0	0.000	0.000	I	I0	0.089	0.133
16 May	23	279.6	65.75	I	0.158	0.241	6	44	0.390	0.594
17 Hay	24	251.3	74.27	I	0.158	0.213	5	33	0.293	0.390
18 May	25	230.2	79.73	I	0.158	0.199	3	30	0.266	0.337
19 May	26	231.1	75.32	I	0.158	0.210	0	0	0.000	0.000
20 Hay	27	202.3	83.80	0	0.000	0.000	I	7	0.062	0.071
21 May	28	181.5	98.74	0	0.000	0.000	0	0	0.000	0.000
22 May	29	195.3	91.89	0	0.000	0.000	I	5	0.044	0.044
23 May	30	190.2	93.60	0	0.000	0.000	0	0	0.000	0.000
24 May	31	182.9	97.20	0	0.000	0.000	0	0	0.000	0.000
25 nay	32	181.8	100.0	0	0.000	0.000	0	0	0.000	0.000
26 May	33	183.3	100.0	0	0.000	0.000	0	0	0.000	0.000
27 nay	34	196.1	100.0	0	0.000	0.000	0	0	0.000	0.000
28 Ray	35	186.6	100.0	I	0.158	0.158	I	I0	0.089	0.089
29 May	36	210.9	96.12	0	0.000	0.000	0	0	0.000	0.000
30 May	37	204.1	100.0	0	0.000	0.000	0	0	0.000	0.000
31 Hay	38	178.7	100.0	0	0.000	0.000	0	0	0.000	0.000
01 Jun	39	173.5	100.0	I	0.158	0.158	0		0.000	0.000
				195	30.903	35.852	182	2.84;	25.259	28.185

a PIT tag recapture dates (24-hour day midnight to midnight) have been shlfted to match the brand date (noon to noon).

Appendix Table BSb.--Summary of daily recovery data for steelhead group 2, released from Wells WDG hatchery, 1987.

Release date: 27 Apr 1987 Release time: 1600 hours
Number branded fish released: 10,898
Number PIT tagged fish released: 632

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number	Percent of release		Number		Percent of release	
				detected	Detected	P.H. Index	Observed	Expanded	Expanded	P.H. index
30 Apr	3	206.1	95.24	2	0.316	0.332	0	0	0.000	0.000
01 May	4	254.1	77.47	21	3.323	4.289	12	171	1.496	I.532
02 May	5	225.6	87.86	32	5.063	5.763	29	305	2.668	3.184
03 May	6	239.7	82.42	27	4.272	5.183	32	337	2.948	3.753
04 May	7	202.9	98.44	25	3.956	4.018	16	437	3.823	1.890
05 May	8	212.6	97.73	17	2.690	2.752	15	385	3.368	3.129
06 may	9	259.0	75.05	10	1.582	2.108	8	178	1.557	2.175
07 may	10	248.8	79.08	22	3.481	4.402	14	24 I	2.108	2.799
08 May	11	241.9	86.24	7	I.108	1.284	6	133	I.164	I.413
09 may	12	269.9	78.91	8	1.266	1.604	10	240	2.100	2.789
10 May	13	253.0	93.76	5	0.791	0.844	4	98	0.857	0.963
I I May	14	222.7	91.17	6	0.949	I.041	11	276	2.415	2.780
12 may	15	260.3	74.66	8	1.266	1.695	5	136	I.190	1.670
13 May	16	279.6	70.01	7	I.108	1.582	6	96	0.840	1.257
14 may	17	269.8	73.96	5	0.791	1.070	2	27	0.236	0.339
15 May	18	263.3	66.79	5	0.791	I.184	6	59	0.516	0.807
16 may	19	279.6	65.75	0	0.000	0.000	5	36	0.315	0.505
17 May	20	251.3	74.27	7	I.108	I.491	6	0	0.000	0.495
18 May	21	230.2	79.73	0	0.000	0.000	8	80	0.700	0.918
19 may	22	231.1	75.32	0	0.000	0.000	2	20	0.175	0.248
20 May	23	202.3	83.80	2	0.316	0.378	3	21	0.184	0.229
21 May	24	181.5	98.74	1	0.158	0.160	0	0	0.000	0.000
22 may	25	195.3	91.89	0	0.000	0.000	0	0	0.000	0.000
23 May	26	190.2	93.60	0	0.000	0.000	1	5	0.044	0.046
24 May	27	182.9	97.20	1	0.158	0.163	1	7	0.061	0.064
25 May	28	181.8	100.0	0	0.000	0.000	0	0	0.000	0.000
26 May	29	183.3	100.0	0	0.000	0.000	0	0	0.000	0.000
27 May	30	196.1	100.0	0	0.000	0.000	0	0	0.000	0.000
28 May	31	186.6	100.0	1	0.158	0.158	0	0	0.000	0.000
29 May	32	210.9	96.12	0	0.000	0.000	1	8	0.070	0.073
30 May	33	204.1	100.0	1	0.158	0.158	1	7	0.061	0.064
				220	34.810	41.662	204	3,303	28.898	33.125

[a] PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

Appendix Table B5c.--Summary of daily recovery data for steelhead group 3, released from Wells WDG hatchery, 1987.

Release date: 01 May 1987 **Release time:** 1600 hours
Number branded fish released: 11,375
Number PIT tagged fish released: 616

Recapture date	Travel days	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
				Number	Percent of release		Number		Percent of release	
				detected	Detected	P.H. index	Observed	Expanded	Expanded	P.H. index
02 May	1	225.6	87.86	0	0.000	0.000	1	11	0.095	0.114
03 May	2	239.7	82.42	0	0.000	0.000	0	0	0.000	0.000
04 May	3	202.9	98.44	20	3.247	3.298	0	0	0.000	0.000
05 May	4	212.6	97.73	39	6.331	6.478	6	154	1.334	1.152
06 May	5	259.0	75.05	25	4.058	5.408	13	289	2.503	3.130
07 May	6	248.8	79.08	28	4.545	5.748	24	414	3.586	4.607
08 May	7	241.9	86.24	18	2.922	3.388	23	511	4.426	5.213
09 May	8	269.9	78.91	21	3.409	4.320	11	264	2.286	2.945
10 May	9	253.0	93.76	19	3.084	3.290	15	367	3.177	3.437
11 May	10	222.7	91.17	10	1.623	1.781	13	327	2.832	3.156
12 May	11	260.3	74.66	13	2.110	2.827	6	164	1.420	1.934
13 May	12	279.6	70.01	7	1.136	1.623	8	128	1.109	1.609
14 May	13	269.8	73.96	10	1.623	2.195	3	40	0.346	0.475
15 May	14	263.3	66.79	4	0.649	0.972	9	89	0.771	1.169
16 May	15	279.6	65.75	2	0.325	0.494	8	58	0.502	0.774
17 May	16	251.3	74.27	4	0.649	0.874	8	53	0.459	0.624
18 May	17	230.2	79.73	3	0.487	0.611	5	50	0.433	0.554
19 May	18	231.1	75.32	4	0.649	0.862	2	20	0.173	0.237
20 May	19	202.3	83.80	2	0.325	0.387	9	62	0.537	0.650
21 May	20	181.5	98.74	0	0.000	0.000	2	13	0.113	0.114
22 May	21	195.3	91.89	0	0.000	0.000	0	0	0.000	0.000
23 May	22	190.2	93.60	0	0.000	0.000	2	10	0.087	0.097
24 May	23	182.9	97.20	0	0.000	0.000	1	7	0.061	0.061
25 May	24	181.8	100.0	0	0.000	0.000	0	0	0.000	0.000
26 May	25	183.3	100.0	0	0.000	0.000	1	7	0.061	0.061
27 May	26	196.1	100.0	0	0.000	0.000	1	5	0.043	0.044
28 May	27	186.6	100.0	0	0.000	0.000	0	0	0.000	0.000
29 May	28	210.9	96.12	0	0.000	0.000	1	8	0.069	0.070
30 May	29	204.1	100.0	0	0.000	0.000	1	7	0.061	0.061
31 May	30	178.7	100.0	0	0.000	0.000	0	0	0.000	0.000
01 Jun	31	173.5	100.0	0	0.000	0.000	0	0	0.000	0.000
02 Jun	32	182.3	100.0	0	0.000	0.000	0	0	0.000	0.000
03 Jun	33	199.9	100.0	0	0.000	0.000	0	0	0.000	0.000
04 Jun	34	187.3	100.0	0	0.000	0.000	0	0	0.000	0.000
05 Jun	35	169.2	100.0	0	0.000	0.000	1	14	0.121	0.123
				229	37.175	44.556	174	3,072	26.607	32.413

[a] PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

Appendix Table B6a.--Summary of daily recovery data for sockeye salmon group 1, released from Priest Rapids Dam, 1987.

Release date: 07 May 1987 through 14 May 1987 Release time: 2300 hours
Number branded fish released: 5.424
Number PIT tagged fish released: 600

Recapture date	River flow	%Power house flow	PIT tag recaptures[a] Number detected	PIT tag recaptures[a] Percent of release Detected	PIT tag recaptures[a] Percent of release P.H. index	Brand recaptures Number Observed	Brand recaptures Number Expanded	Brand recaptures Percent of release Expanded	Brand recaptures Percent of release P.H. index
10 May	253.0	93.16	0	0.000	0.000	0	0	0.00000	0.00000
11 May	222.7	91.17	33	5.500	6.500	0	0	0.00000	0.00000
12 May	260.3	14.66	26	4.333	5.667	6	164	3.02360	4.05605
13 May	279.6	70.01	6	1.000	1.333	6	96	1.76991	2.52581
14 May	269.8	73.96	8	1.333	1.667	16	213	3.92699	5.30973
15 May	263.3	66.79	20	3.333	4.833	7	69	1.27212	1.89897
16 May	279.6	65.75	38	6.333	9.500	25	182	3.35546	5.10693
17 May	251.3	74.27	30	5.000	6.667	33	220	4.05605	5.45723
18 May	230.2	79.73	9	1.500	1.833	18	160	2.94985	3.70575
19 May	231.1	75.32	15	2.500	3.167	6	41	1.47493	1.95428
20 May	202.3	83.80	8	1.333	1.500			0.75590	0.90339
21 May	181.5	98.74	6	1.000	1.000	3	20	0.36673	0.36873
22 May	195.3	91.89	0	0.000	0.000	6	30	0.55310	0.60841
23 May	190.2	93.60	4	0.667	0.667	6	30	0.55310	0.58997
24 May	182.9	97.20	1	0.167	0.167	3	20	0.36873	0.38717
25 May	181.8	100.0	0	0.000	0.000	1	7	0.12906	0.12906
26 May	183.3	100.0	1	0.167	0.167	1	7	0.12906	0.12906
27 May	196.1	100.0	0	0.000	0.000	1	5	0.09218	0.09218
28 May	186.6	100.0	0	0.000	0.000	4	40	0.73746	0.73746
29 May	210.9	96.12	0	0.000	0.000	2	16	0.29499	0.31342
30 May	204.1	100.0	0	0.000	0.000	29	193	3.55826	3.55826
31 May	178.7	100.0	0	0.000	0.000	1	7	0 12906	0.12906
	4834.0	1926.0	205	34.167	44.667	180	1.600	29.49850	37.96090

[a] PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

Appendix Table B6b.--Summary of daily recovery data for sockeye salmon group 2, released from Priest Rapids Dam, 1987.

Release date: 18 May 1987 through 23 May 1987 **Release time:** 2300 hours
Number branded fish released: 5,349
Number PIT tagged fish released: 600

Recapture date	River flow	%Power house flow	PIT tag recaptures[a]			Brand recaptures			
			Number detected	Percent of release Detected	P.H. index	Number Observed	Expanded	Percent of release Expanded	P.H. index
22 May	195.3	91.89	3	0.500	0.500	0	0	0.000	0.000
23 May	190.2	93.60	23	3.833	4.000	21	105	1.963	2.094
24 May	182.9	97.20	14	2.333	2.333	33	220	4.113	4.225
25 Hay	181.8	100.0	49	8.167	8.167	28	187	3.496	3.496
26 May	183.3	100.0	23	3.833	3.833	24	160	2.991	2.991
27 May	196.1	100.0	43	7.167	7.167	29	145	2.711	2.711
28 May	186.6	loo.0	25	4.167	4.167	22	221	4.132	4.132
29 May	210.9	96.12	14	2.333	2.333	19	155	2.898	3.010
30 May	204.1	100.0	16	2.667	2.667	16	107	2.000	2.000
31 May	178.7	100.0	7	I.167	I.167	8	53	0.991	0.991
01 Jun	173.5	100.0	6	1.000	I . oon	7	47	0.879	0.879
02 Jun	182.3	100.0	2	0.333	0.333	2	13	0.243	0.243
03 Jun	199.9	100.0		0.167	0.167	2	7	0.131	0.131
04 Jun	187.3	100.0	0	0.000	0.000	4	13	0.243	0.243
05 Jun	169.2	100.0	0	0.000	0.000	0	0	0.000	0.000
06 Jun	192.4	100.0		0.167	0.167	1	14	0.262	0.262
07 Jun	190.7	100.0	0	0.000	0.000	0	0	0.000	0.000
08 Jun	194.0	100.0	0	0.000	0.000	0	0	0.000	0.000
09 Jun	182.4	100.0	1	0.167	0.167	0	0	0.000	0.000
10 Jun	198.8	100.0	0	0.1100	0.000	0	0	0.000	0.000
11 Jun	187.5	100.0	n	0.000	0.000	2	2	0.037	0.037
			228	38.000	38.167	218	1,449	27.089	27.444

[a] PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

Appendix Table B6c.-- Summary of daily recovery data for sockeye salmon group 3, released from Priest Rapids Dam, 1987.

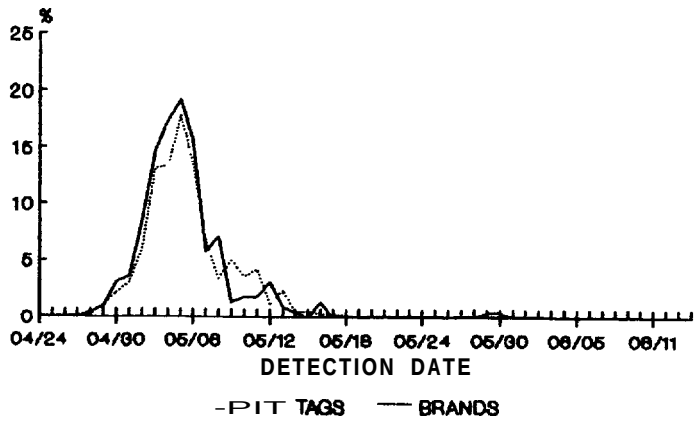
Release date: 24 Hay 1987 through 25 May 1987 Release time: 2300 hours
Number branded fish released: 5.050
Number PIT tagged fish released: 600

Recapture date	River flow	%Power house flow	PIT tag recaptures[a] Number detected	Percent of release Detected	P.H.	Index	Brand recaptures Number Observed	Expanded	Percent of release Expanded	P.H.	index
27 Hay	196. 1	100.0	32	5.333	5.333		17	85	1.683	1.683	
28 Ray	186.6	100.0	34	5.667	5.667		15	151	2.990	2.990	
29 Hay	210.9	96. 12	38	6.333	6.500		13	106	2.099	2.178	
30 May	204. I	100.0	27	4.500	4.500		0	0	0.000	0.000	
31 Hay	176.7	100.0	28	4.667	4.667		12	80	1.584	1.584	
01 Jun	173.5	100.0	5	0.833	0.833		6	40	0.792	0.792	
02 Jun	182.3	100.0	I	0.167	0.167		6	40	0.792	0.792	
03 Jun	199.9	too.0	5	0.833	0.833		I	3	0.059	0.059	
04 Jun	187.3	100.0	1	0.167	0.167		3	I0	0.198	0.198	
05 Jun	169.2	100.0	3	0.500	0.500		1	14	0.277	0.277	
06 Jun	192.4	100.0	I	0.167	0.167		I	14	0.277	0.277	
07 Jun	190.7	100.0	5	0.833	0.833		2	29	0.574	0.574	
08 Jun	194.0	100.0	0	0.000	0.000		0	0	0.000	0.000	
09 Jun	182.4	100.0	0	0.000	0.000		0	0	0.000	0.000	
10 Jun	198.8	100.0	0	0.000	0.000		0	0	0.000	0.000	
I I Jun	140.0	100.0	0	0.000	0.000		1	I	0.020	0.020	
12 Jun	154.7	100.0	I	0.167	0.167		0	0	0.000	0.000	
13 Jun	140.0	100.0	0	0.000	0.000		0	0	0.000	0.000	
14 Jun	123.0	100.0	0	0.000	0.000		0	0	0.000	0.000	
19 Jun		100.0	I	0.167	0.167		0	0	0.000	0.000	
23 Jun		100.0	1	0.167	0.167		0	0	0.000	0.000	
			183	30.500	30.667		78	573	11.346	11.425	

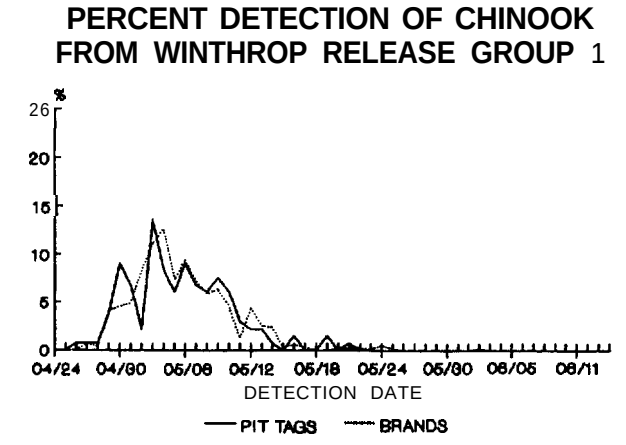
[a] PIT tag recapture dates (24-hour day midnight to midnight) have been shifted to match the brand date (noon to noon).

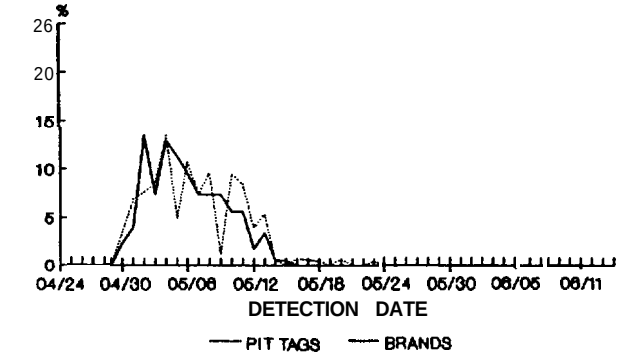
APPENDIX C

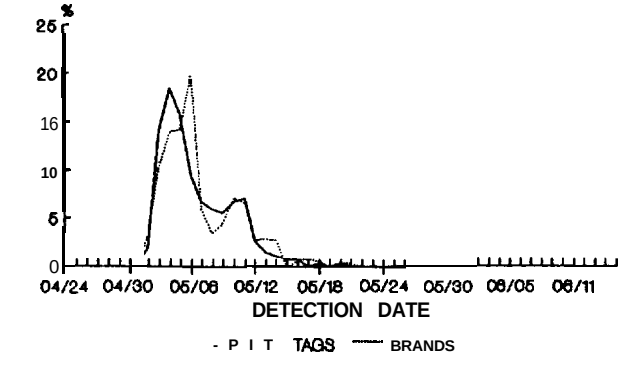
Figures of Recaptures by Date



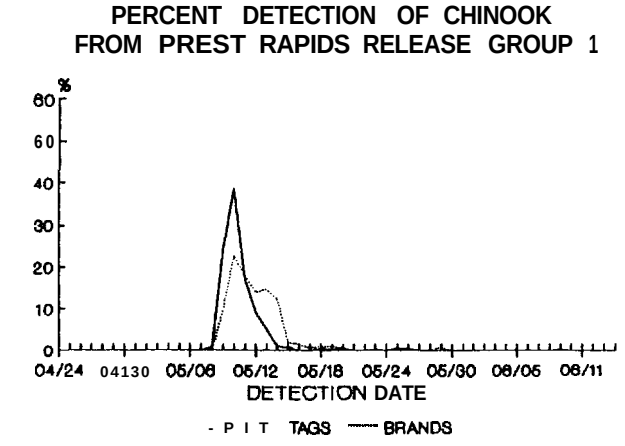
Appendix Figure C1.--Detection of Lyons Ferry Hatchery yearling fall chinook salmon at McNary Dam in 1987, calculated as percentage of total recaptures.

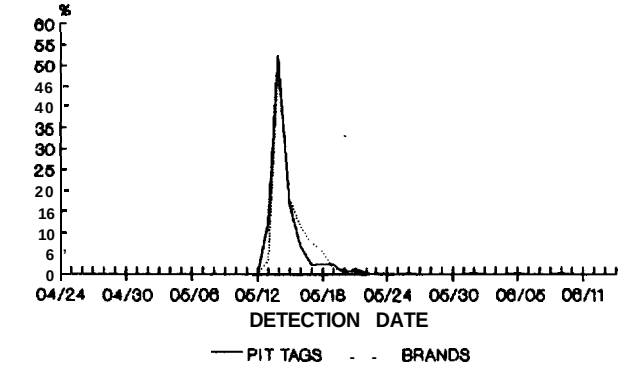


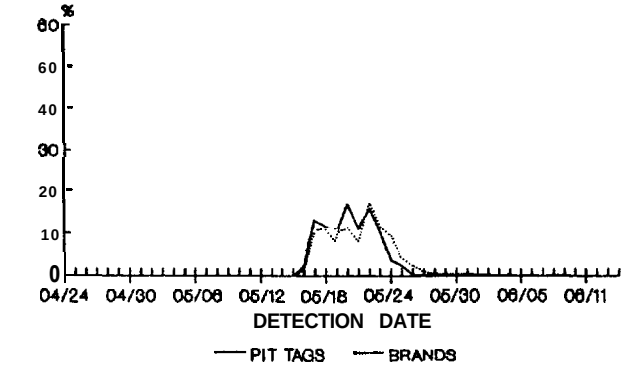




Appendix Figure C2.--Detection of Winthrop Hatchery spring chinook salmon at McNary Dam in 1987, calculated as percentage of total recaptures.

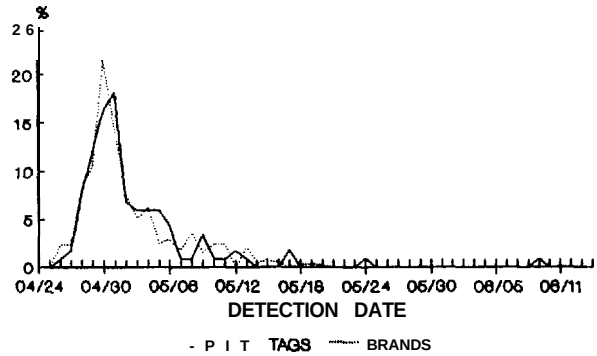






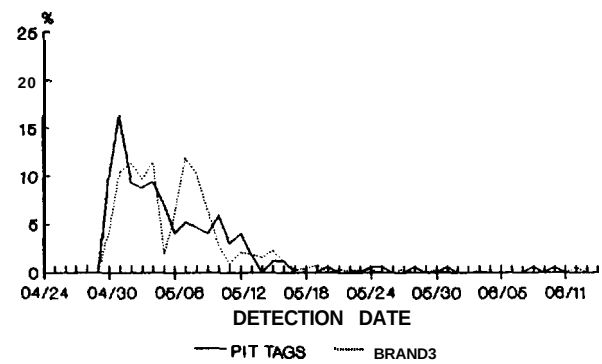
Appendix Figure C3.--Detection of Priest Rapids Dam migrant yearling chinook salmon at McNary Dam in 1987, calculated as percentage of total recaptures.

PERCENT DETECTION OF STEELHEAD
FROM LYONS FERRY RELEASE GROUP 1



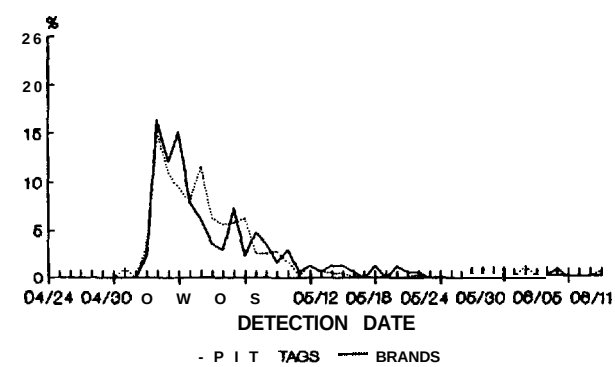
Released 28 April 1987 at Ice Harbor Dam

PERCENT DETECTION OF STEELHEAD FROM LYONS FERRY RELEASE GROUP 2



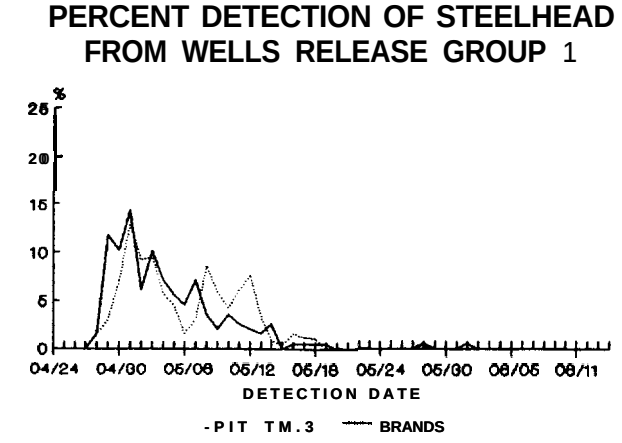
Released 27 April 1987 at Ice Harbor Dam

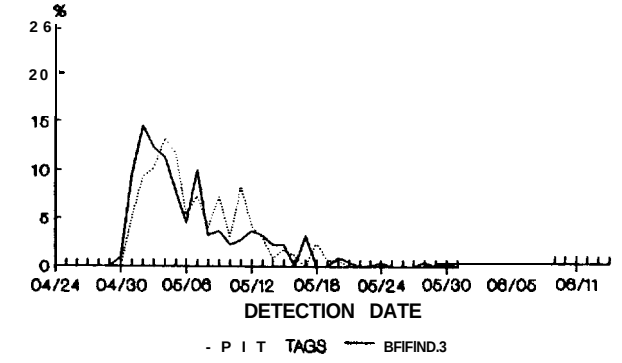
PERCENT DETECTION OF STEELHEAD FROM LYONS FERRY RELEASE GROUP 3

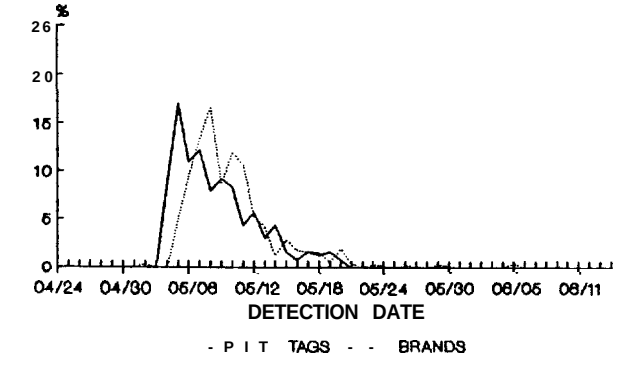


Released 1 May 1987 at Ice Harbor Dam

Appendix Figure &.--Detection of Lyons Ferry Hatchery steelhead at McNary Dam in 1987, calculated as percentage of total recaptures.

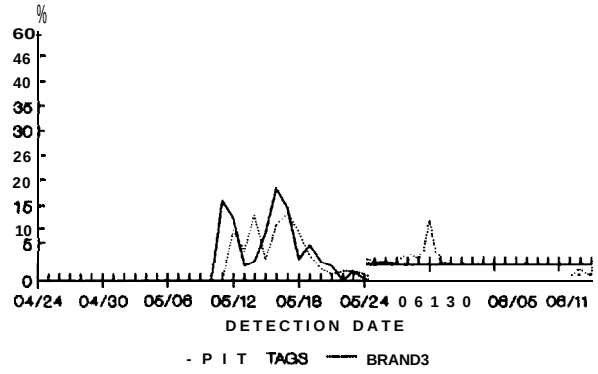






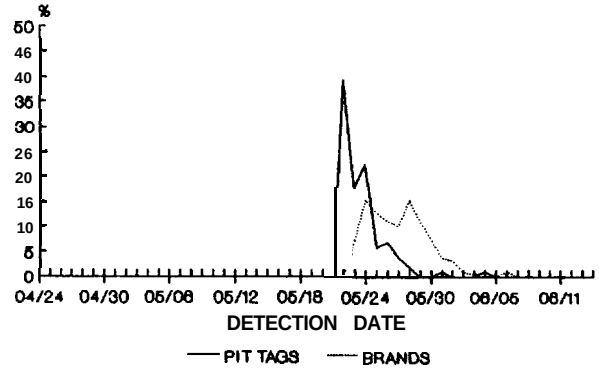
Appendix Figure C5.--Detection of Wells Hatchery steelhead at McNary Dam in 1987, calculated as percentage of total recaptures.

PERCENT DETECTION OF SOCKEYE FROM PRIEST RAPIDS RELEASE GROUP 1



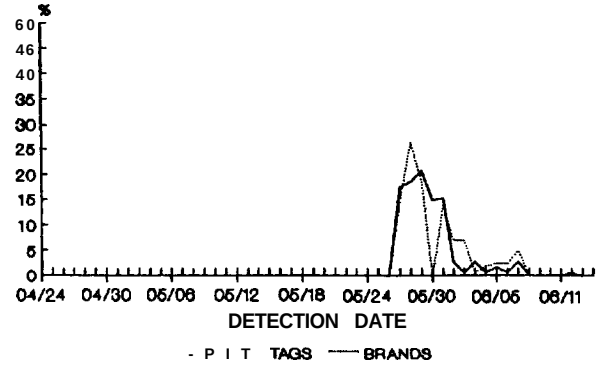
Released 7-14 May 1987 .t Priest Rapids

PERCENT DETECTION OF SOCKEYE FROM PREST RAPIDS RELEASE GROUP 2



Released 18-20 May 1987 at Priest Rapids

PERCENT DETECTION OF SOCKEYE FROM PRIEST RAPIDS RELEASE GROUP 3



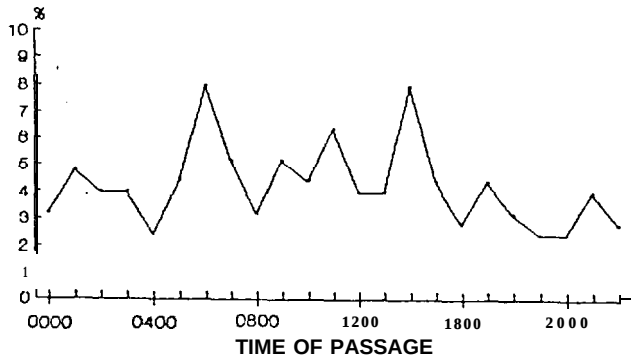
Released 24-26 May 1987 at Priest Rapids

Appendix Figure C6.--Detection of Priest Rapids migrant sockeye salmon at McNary Dam in 1987, calculated as percentage of total recaptures.

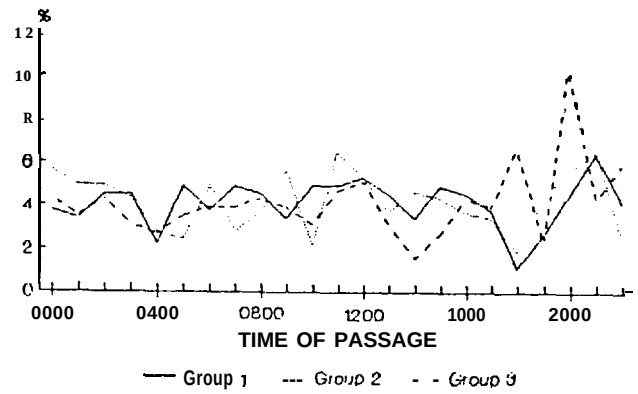
APPENDIX D

Figures of Diel Passage

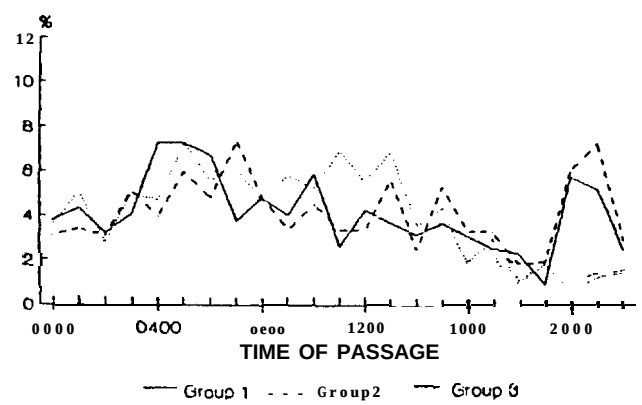
DIEL PASSAGE OF LYONS FERRY CHINOOK
AT McNARY DAM IN 1987



DIEL PASSAGE OF WINTHROP CHINOOK
AT McNARY DAM IN 1987

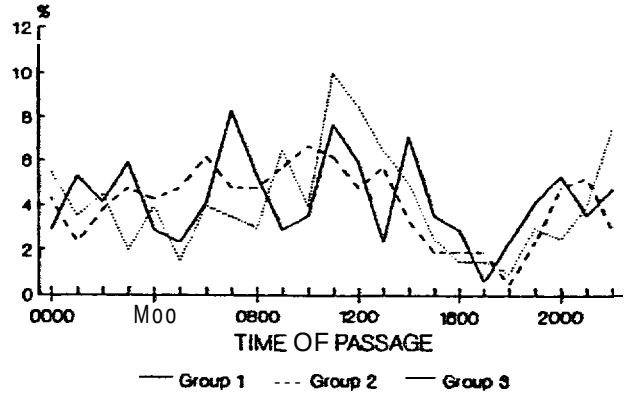


DIEL PASSAGE OF PRIEST RAPIDS CHINOOK
AT McNARY DAM IN 1987

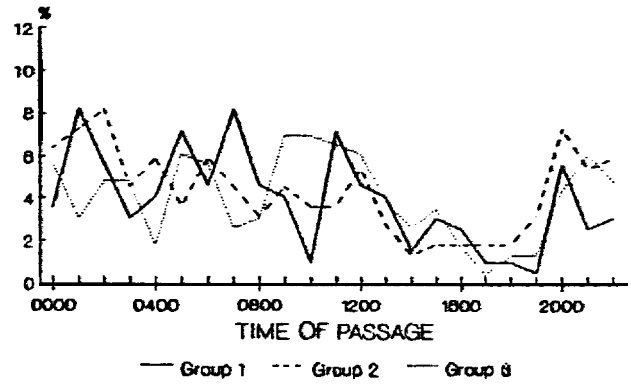


Appendix Figure D1.--Diel passage of PIT-tagged yearling chinook salmon detected while exiting the separator at McNary Dam in 1987.

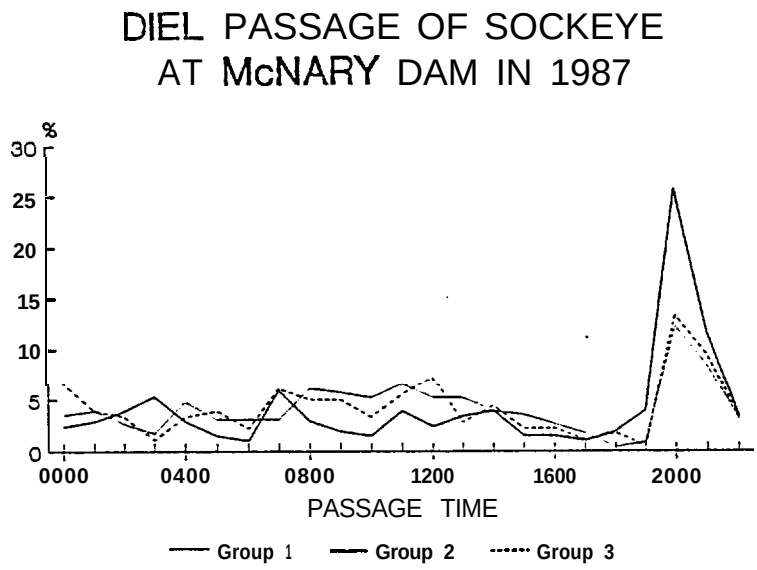
DIEL PASSAGE OF LYONS FERRY STEELHEAD
AT McNARY DAM IN 1987



DEL PASSAGE OF WELLS STEELHEAD
AT McNARY DAM IN 1987



Appendix Figure D2.--Diel passage of PIT-tagged steelhead detected while exiting the separator at McNary Dam in 1987.



Appendix Figure D3. --Diel passage of PIT-tagged sockeye salmon detected while exiting the separator at McNary Dam in 1987.

APPENDIX E

Budget Information

Budget Information
FY87

Salaries	**$14,283.74**
Travel	**2,379.29**
Transport	**1,789.74**
Rents	956.37
Printing	0
Contract Service	**1,729.00**
Supplies	687.84
Equipment	0
Support	5.096.42
TOTAL	**$26,922.40**